US008286568B2

(12) **United States Patent**
Tokura

(10) **Patent No.: US 8,286,568 B2**
(45) **Date of Patent: Oct. 16, 2012**

(54) **SEWING MACHINE AND COMPUTER-READABLE MEDIUM STORING SEWING MACHINE CONTROL PROGRAM**

(75) Inventor: **Masashi Tokura**, Nagoya (JP)

(73) Assignee: **Brother Kogyo Kabushiki Kaisha**, Nagoya (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 298 days.

(21) Appl. No.: **12/847,540**

(22) Filed: **Jul. 30, 2010**

(65) **Prior Publication Data**

US 2011/0048300 A1 Mar. 3, 2011

(30) **Foreign Application Priority Data**

Sep. 3, 2009 (JP) 2009-203648

(51) **Int. Cl.**
D05B 21/00 (2006.01)
D05C 5/06 (2006.01)

(52) **U.S. Cl.** **112/102.5**; 700/137

(58) **Field of Classification Search** 112/470.01–470.14, 98, 99, 102–103, 112/274–277, 220, 221; 700/136–138
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,784,071	A *	11/1988	Sadeh et al.	112/470.07
5,027,726	A *	7/1991	Brower et al.	112/117
5,191,536	A *	3/1993	Komuro et al.	700/138
5,537,945	A	7/1996	Sugihara et al.	
5,911,182	A	6/1999	Uyama et al.	
5,943,972	A	8/1999	Hirata	
6,167,822	B1	1/2001	Miyasako et al.	
6,755,141	B2 *	6/2004	Musco et al.	112/475.05
7,290,492	B2	11/2007	Watanabe et al.	
7,854,207	B2	12/2010	Kuki et al.	
8,061,286	B2 *	11/2011	Hirata et al.	112/470.01
2007/0199492	A1	8/2007	Ishii	
2009/0020054	A1	1/2009	Taguchi et al.	
2009/0188413	A1	7/2009	Hirata et al.	
2009/0188414	A1	7/2009	Tokura	

(Continued)

FOREIGN PATENT DOCUMENTS

JP	U-58-117795	8/1983

(Continued)

OTHER PUBLICATIONS

U.S. Appl. No. 12/659,224, filed Mar. 1, 2010, in the name of Masashi Tokura.

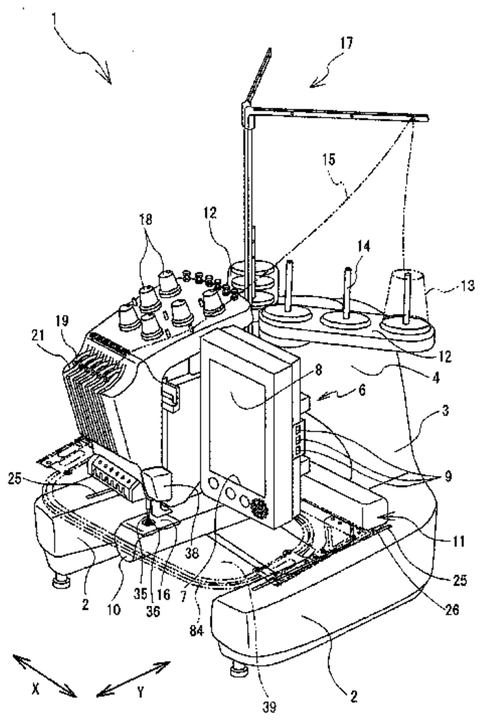
(Continued)

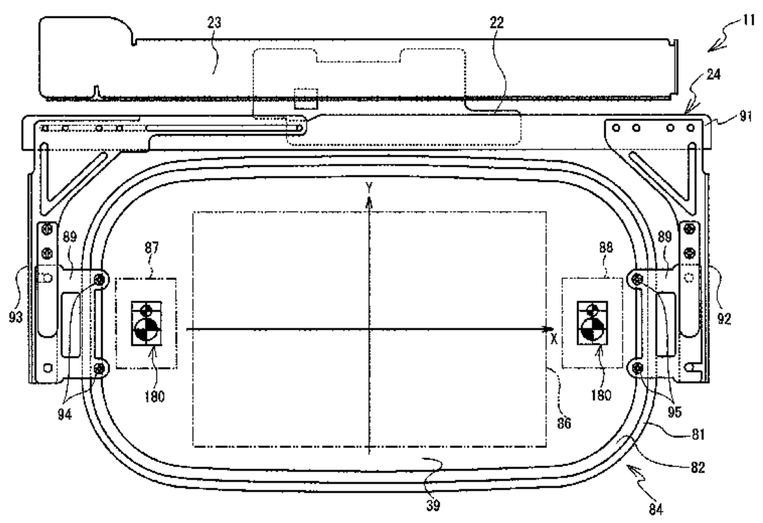
Primary Examiner — Ismael Izaguirre
(74) *Attorney, Agent, or Firm* — Oliff & Berridge, PLC

(57) **ABSTRACT**

A sewing machine that is included in a sewing system includes a transfer device, a sewing device, an image capture device, a communication device, a data computation device, a first control device, a marker data acquisition device, a sewing condition acquisition device, a condition computation device, a correction device, and a sewing control device. The data computation device computes first marker data, and the first control device transmits the first marker data, through the communication device, to another sewing machine. The marker data acquisition device acquires, as second marker data, the first marker data. The sewing condition acquisition device acquires a sewing condition, and the pattern data acquisition device acquires pattern data. The condition computation device computes a correction condition. The correction device corrects the pattern data. The sewing control device performs the sewing in accordance with the corrected pattern data.

8 Claims, 12 Drawing Sheets





U.S. PATENT DOCUMENTS

2011/0048299 A1* 3/2011 Tokura 112/102.5

FOREIGN PATENT DOCUMENTS

JP	A-63-177894	7/1988
JP	H-5-38703	9/1993
JP	A-6-205885	7/1994
JP	A-6-339588	12/1994
JP	A-7-255968	10/1995
JP	A-10-137467	5/1998
JP	A-11-99294	4/1999
JP	A-11-229262	8/1999
JP	A-11-244561	9/1999
JP	A-2003-71176	3/2003
JP	A-2004-180993	7/2004
JP	A-2005-74117	3/2005
JP	A-2006-130124	5/2006
JP	A-2007-105138	4/2007
JP	A-2009-22400	2/2009
JP	A-2009-172119	8/2009
JP	A-2009-172123	8/2009
WO	WO 2009/085005 A1	7/2009

OTHER PUBLICATIONS

U.S. Appl. No. 12/847,527, filed Jul. 30, 2010, in the name of Masashi Tokura.

U.S. Appl. No. 12/857,147, filed Aug. 16, 2010, in the name of Masashi Tokura.

Japanese Office Action issued in Japanese Patent Application No. 2009-203638 (with translation).

European Search Report issued in European Application No. 10153687.8 on Jul. 15, 2011.

Japanese Office Action issued in Japanese Application No. 2009-203649 on Jul. 26, 2011 (with translation).

* cited by examiner

FIG. 1

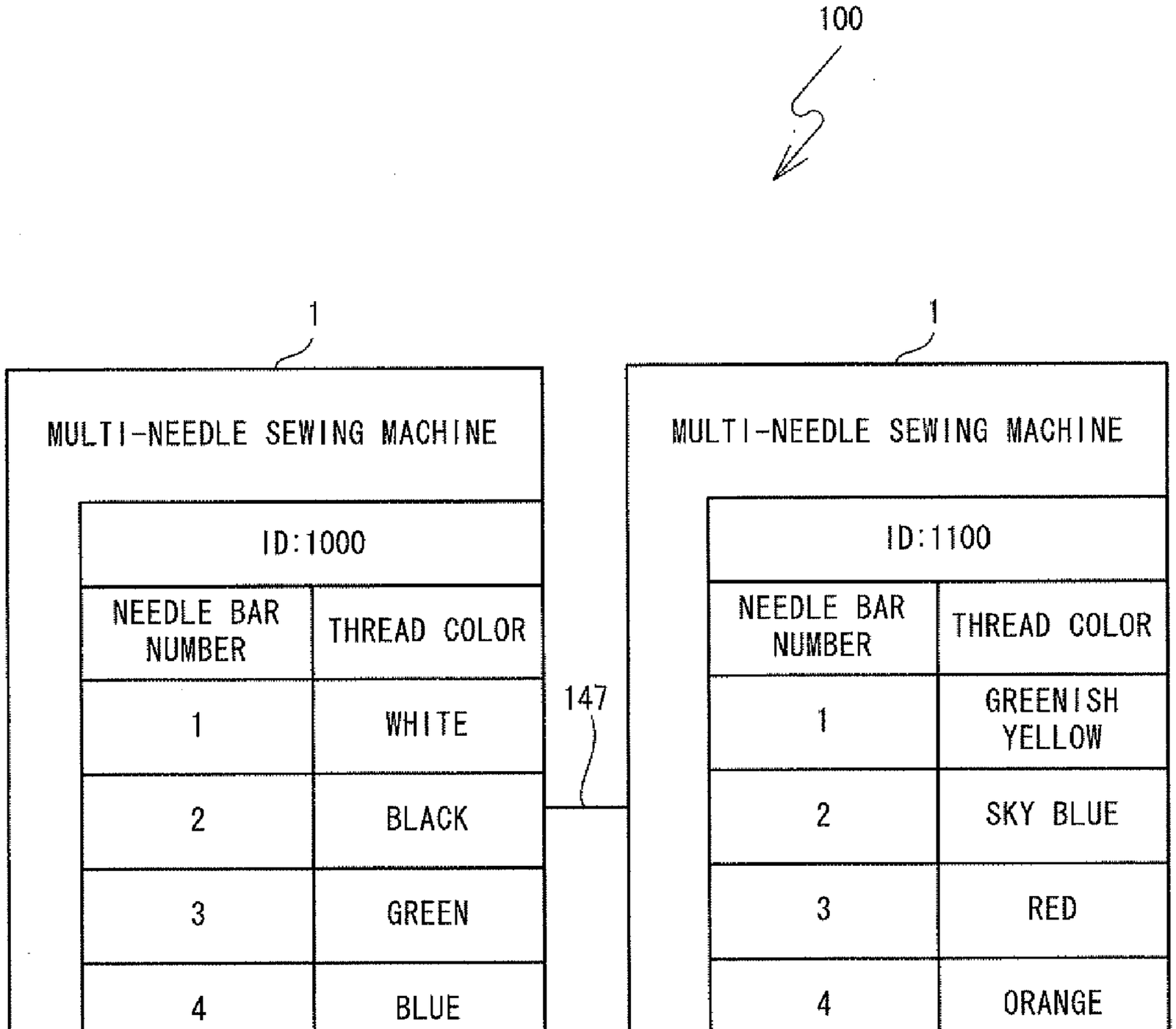

100
1
MULTI-NEEDLE SEWING MACHINE
ID:1000
NEEDLE BAR NUMBER
THREAD COLOR
1 WHITE
2 BLACK
3 GREEN
4 BLUE
5 SKY BLUE
6 YELLOW
147
1
MULTI-NEEDLE SEWING MACHINE
ID:1100
NEEDLE BAR NUMBER
THREAD COLOR
1 GREENISH YELLOW
2 SKY BLUE
3 RED
4 ORANGE
5 BLUE
6 BLACK

FIG. 2

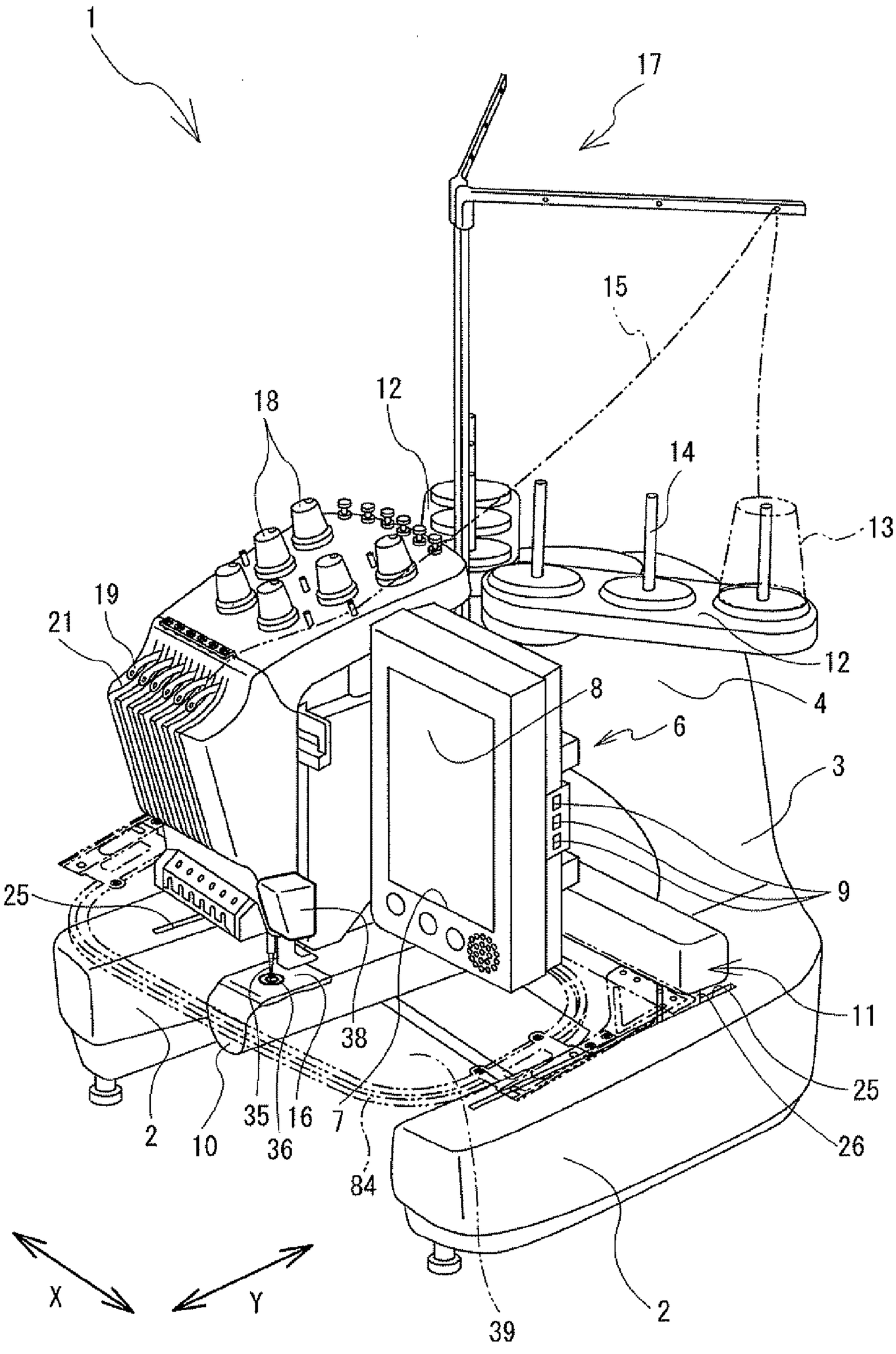

1
17
15
18
12
14
13
19
21
12
8
4
6
3
9
25
11
38
25
26
2
10
35
36
16
7
84
39
2
X
Y

FIG. 3

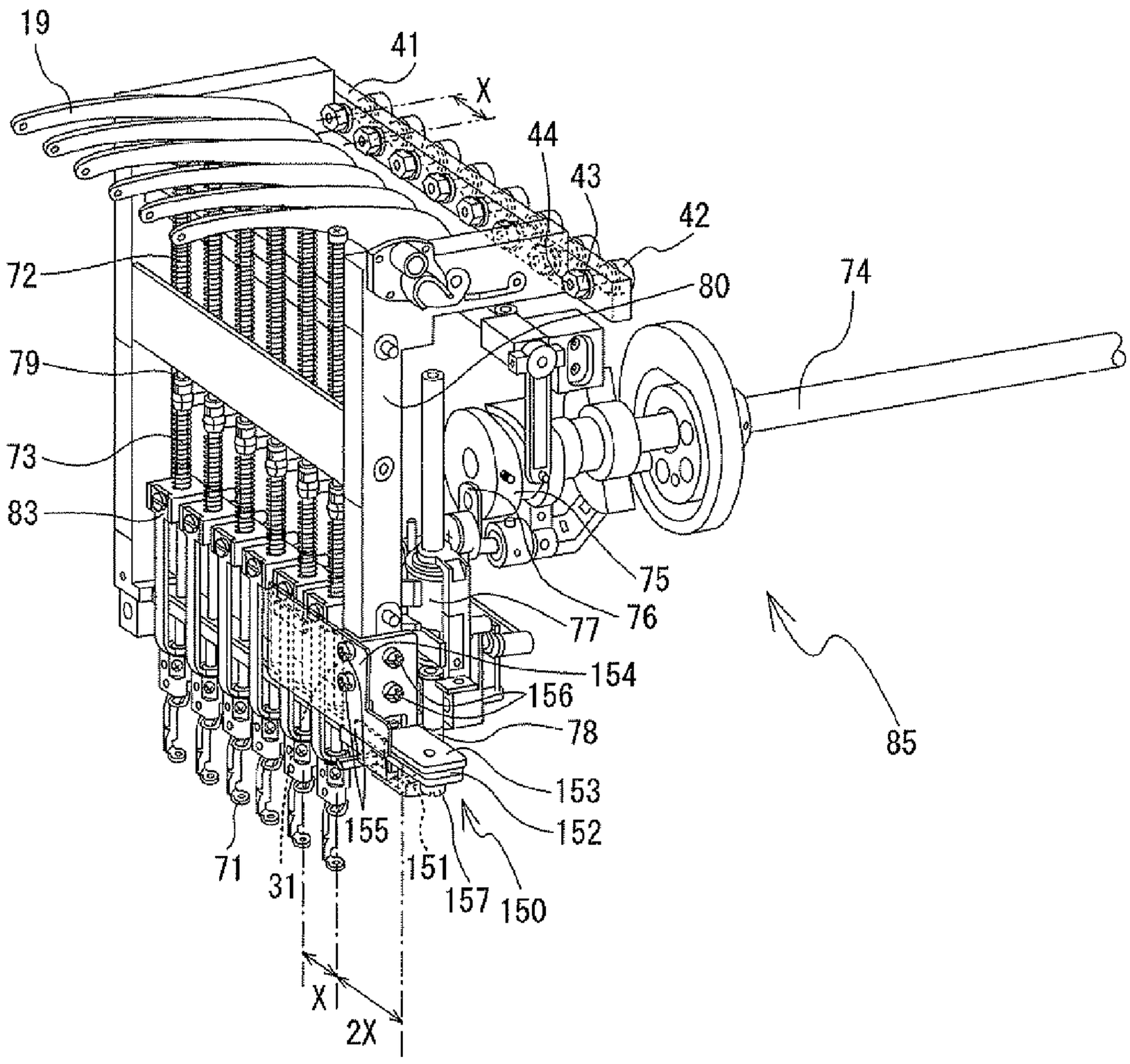

19
41
X
44
43
42
72
80
74
79
73
83
75
76
77
154
156
78
153
152
155
151
157
150
71
31
X
2X
85

FIG. 4

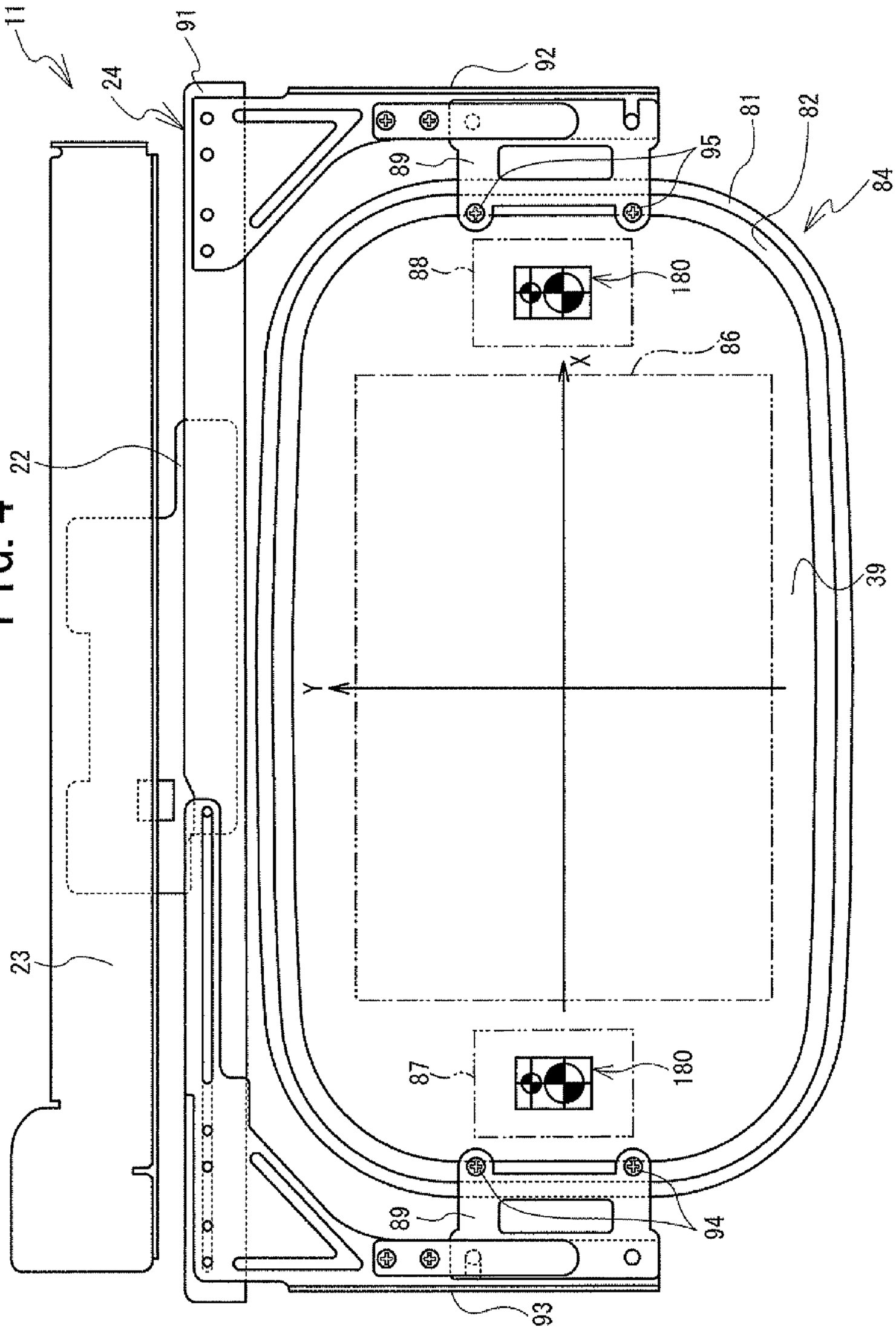


FIG. 5

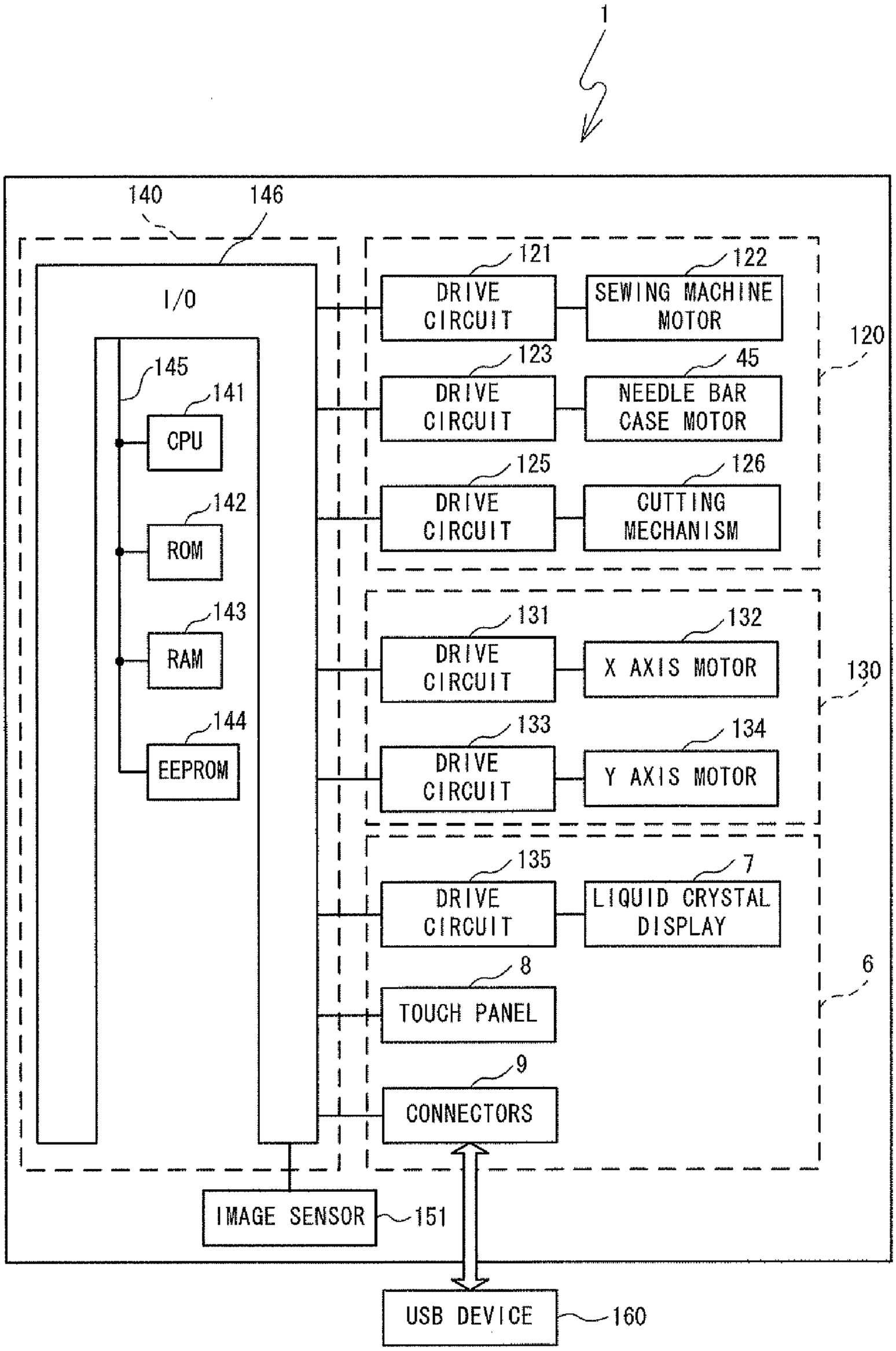

1
140
146
I/O
145
141
CPU
142
ROM
143
RAM
144
EEPROM
121
DRIVE CIRCUIT
122
SEWING MACHINE MOTOR
120
123
DRIVE CIRCUIT
45
NEEDLE BAR CASE MOTOR
125
DRIVE CIRCUIT
126
CUTTING MECHANISM
131
DRIVE CIRCUIT
132
X AXIS MOTOR
130
133
DRIVE CIRCUIT
134
Y AXIS MOTOR
135
DRIVE CIRCUIT
7
LIQUID CRYSTAL DISPLAY
8
TOUCH PANEL
6
9
CONNECTORS
IMAGE SENSOR
151
USB DEVICE
160

FIG. 6

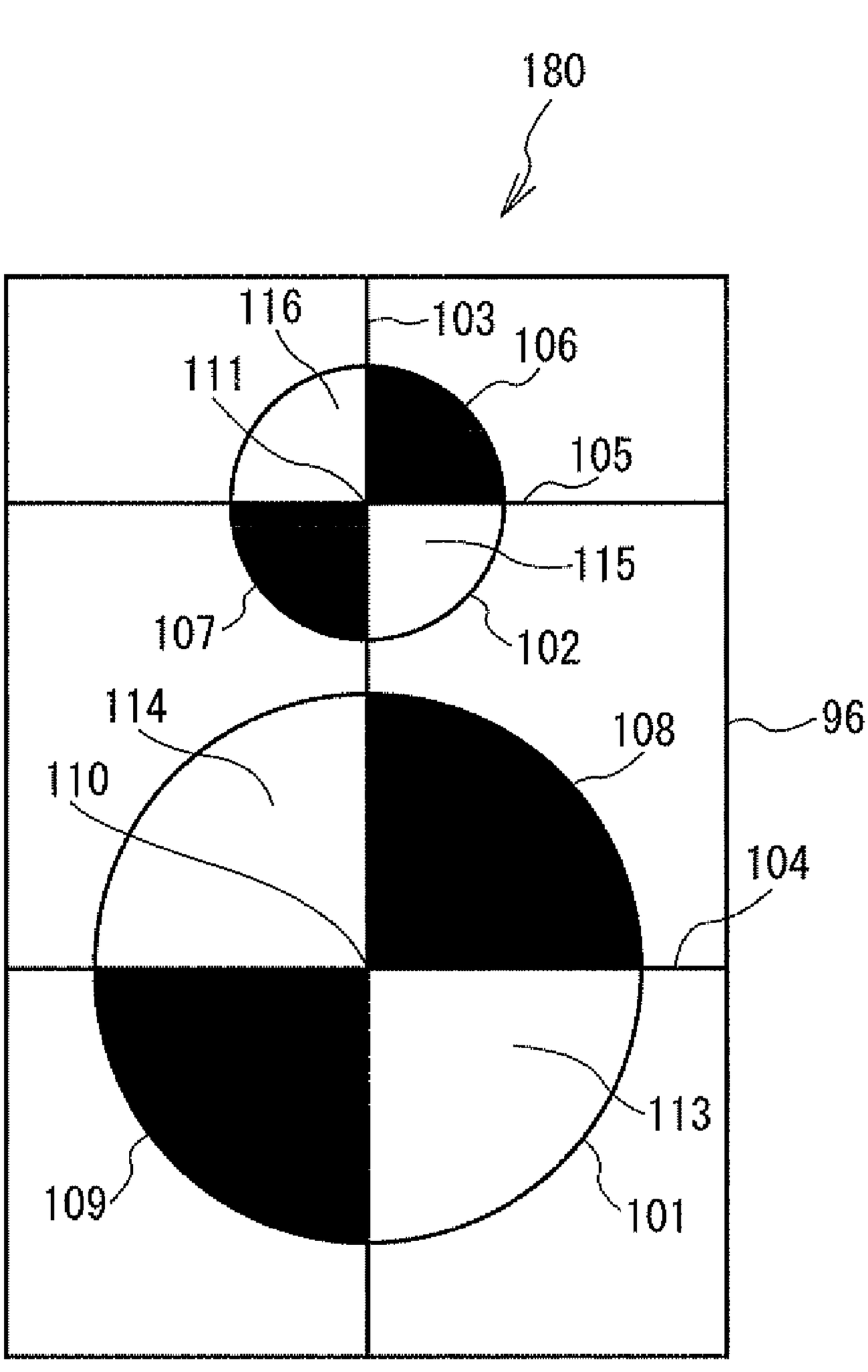

180
116
103
106
111
105
115
107
102
114
108
96
110
104
113
109
101

FIG. 7

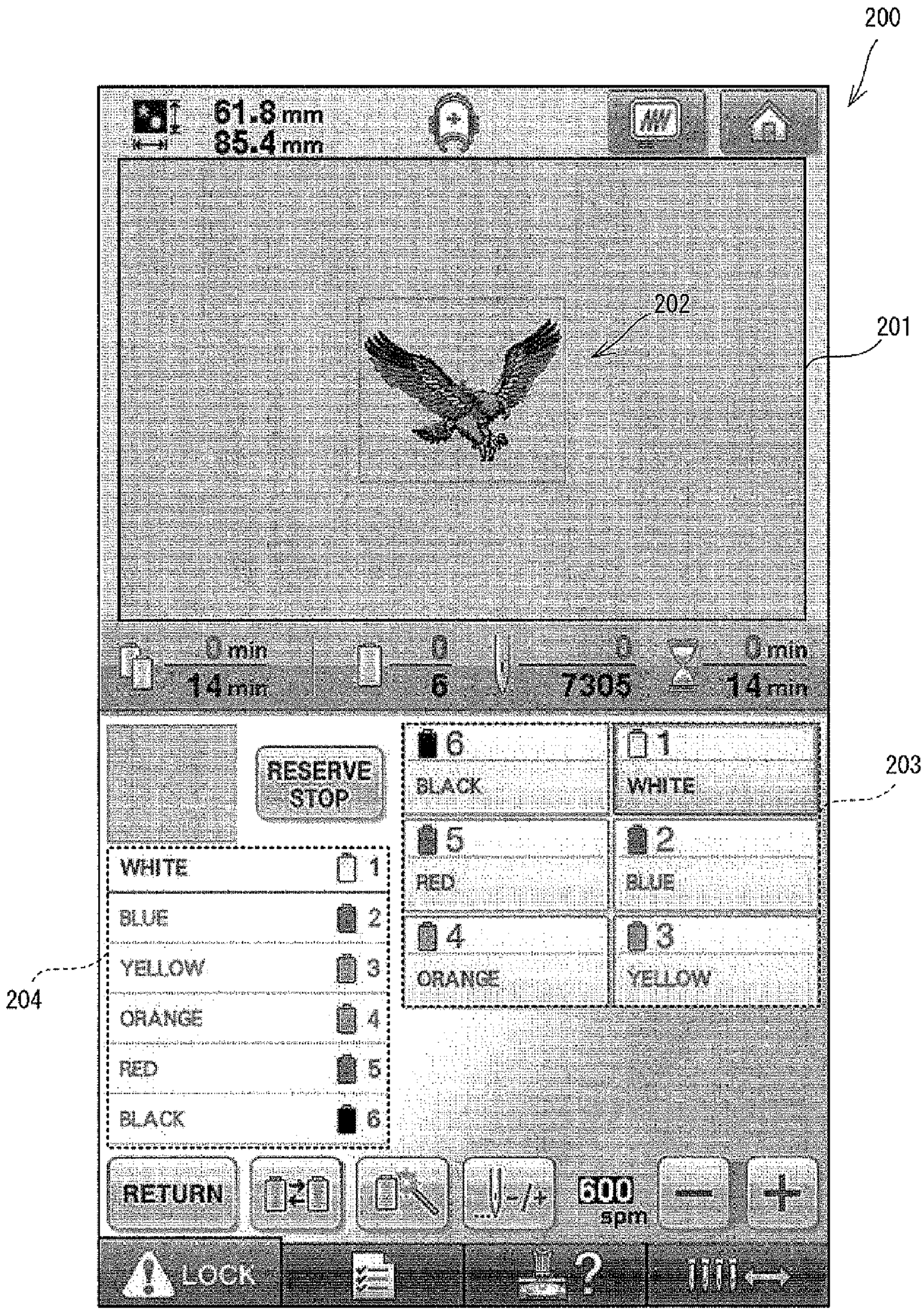

200
61.8 mm
85.4 mm
202
201
0 min
14 min
0
6
0
7305
0 min
14 min
RESERVE
STOP
6
BLACK
1
WHITE
5
RED
2
BLUE
4
ORANGE
3
YELLOW
203
WHITE 1
BLUE 2
YELLOW 3
ORANGE 4
RED 5
BLACK 6
204
RETURN
600
spm
LOCK

FIG. 8

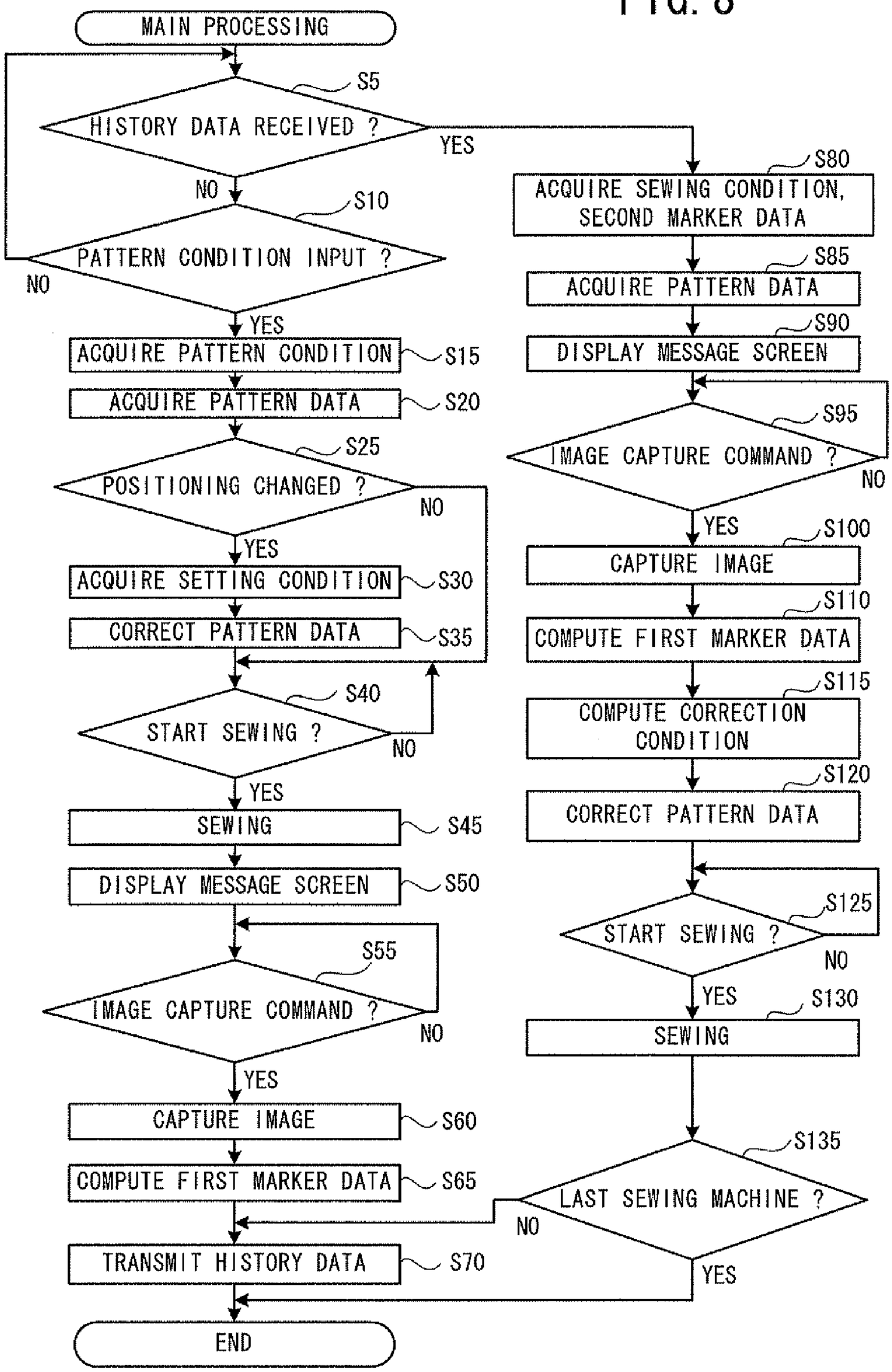

MAIN PROCESSING
S5
HISTORY DATA RECEIVED ?
YES
NO
S10
PATTERN CONDITION INPUT ?
NO
YES
ACQUIRE PATTERN CONDITION
S15
ACQUIRE PATTERN DATA
S20
S25
POSITIONING CHANGED ?
NO
YES
ACQUIRE SETTING CONDITION
S30
CORRECT PATTERN DATA
S35
S40
START SEWING ?
NO
YES
SEWING
S45
DISPLAY MESSAGE SCREEN
S50
S55
IMAGE CAPTURE COMMAND ?
NO
YES
CAPTURE IMAGE
S60
COMPUTE FIRST MARKER DATA
S65
TRANSMIT HISTORY DATA
S70
END
S80
ACQUIRE SEWING CONDITION, SECOND MARKER DATA
S85
ACQUIRE PATTERN DATA
S90
DISPLAY MESSAGE SCREEN
S95
IMAGE CAPTURE COMMAND ?
NO
YES
S100
CAPTURE IMAGE
S110
COMPUTE FIRST MARKER DATA
S115
COMPUTE CORRECTION CONDITION
S120
CORRECT PATTERN DATA
S125
START SEWING ?
NO
YES
S130
SEWING
S135
LAST SEWING MACHINE ?
NO
YES

FIG. 9

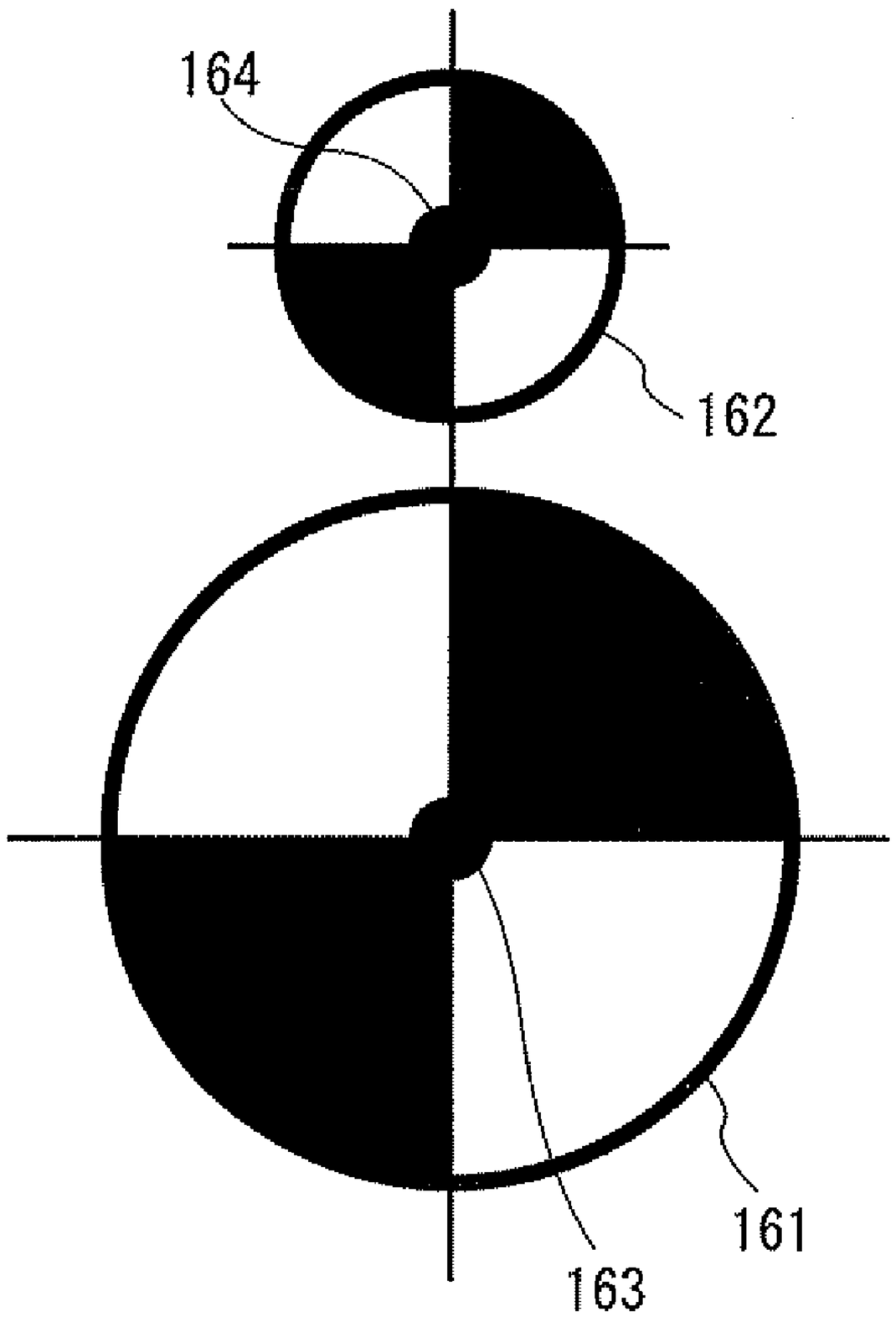


FIG. 10

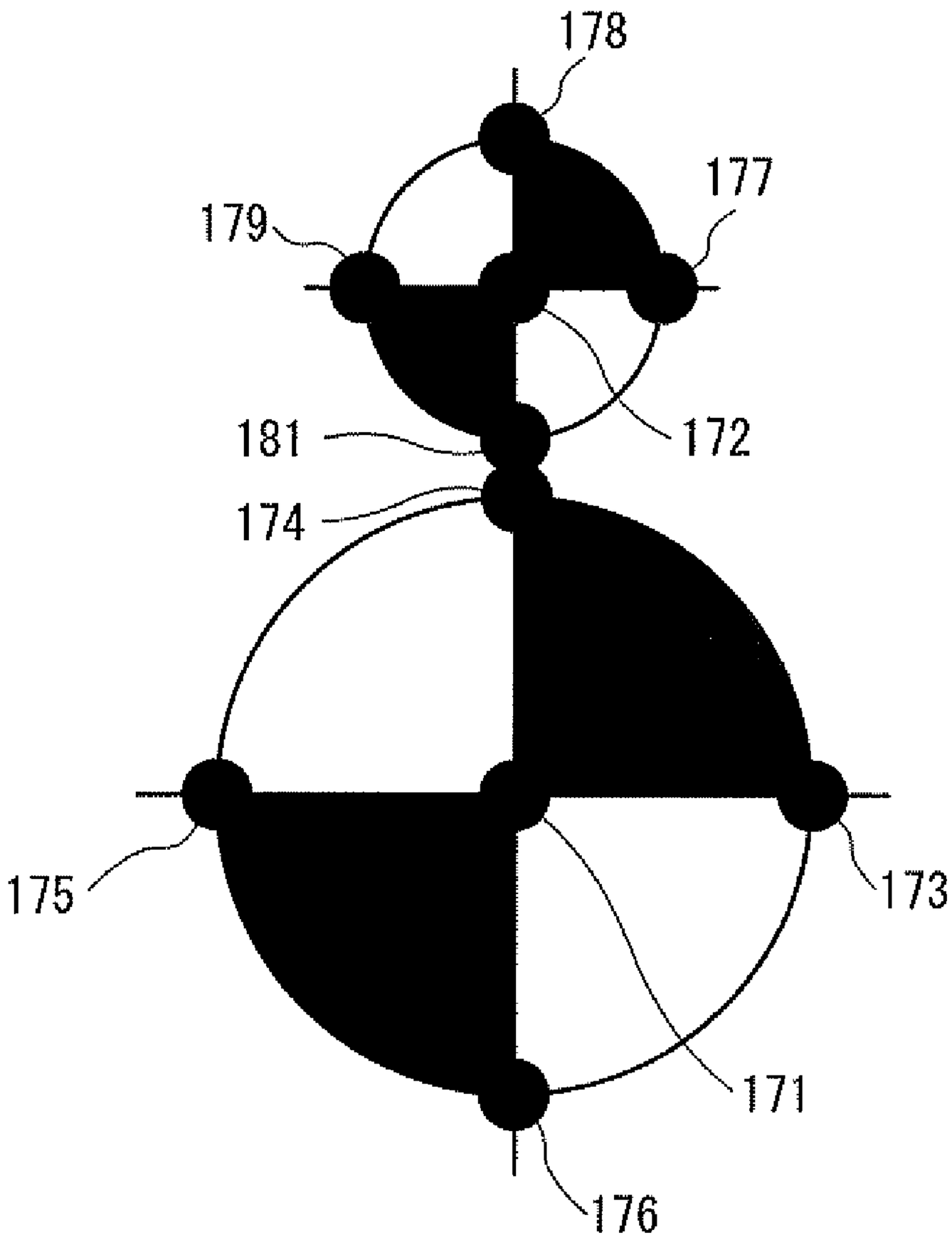
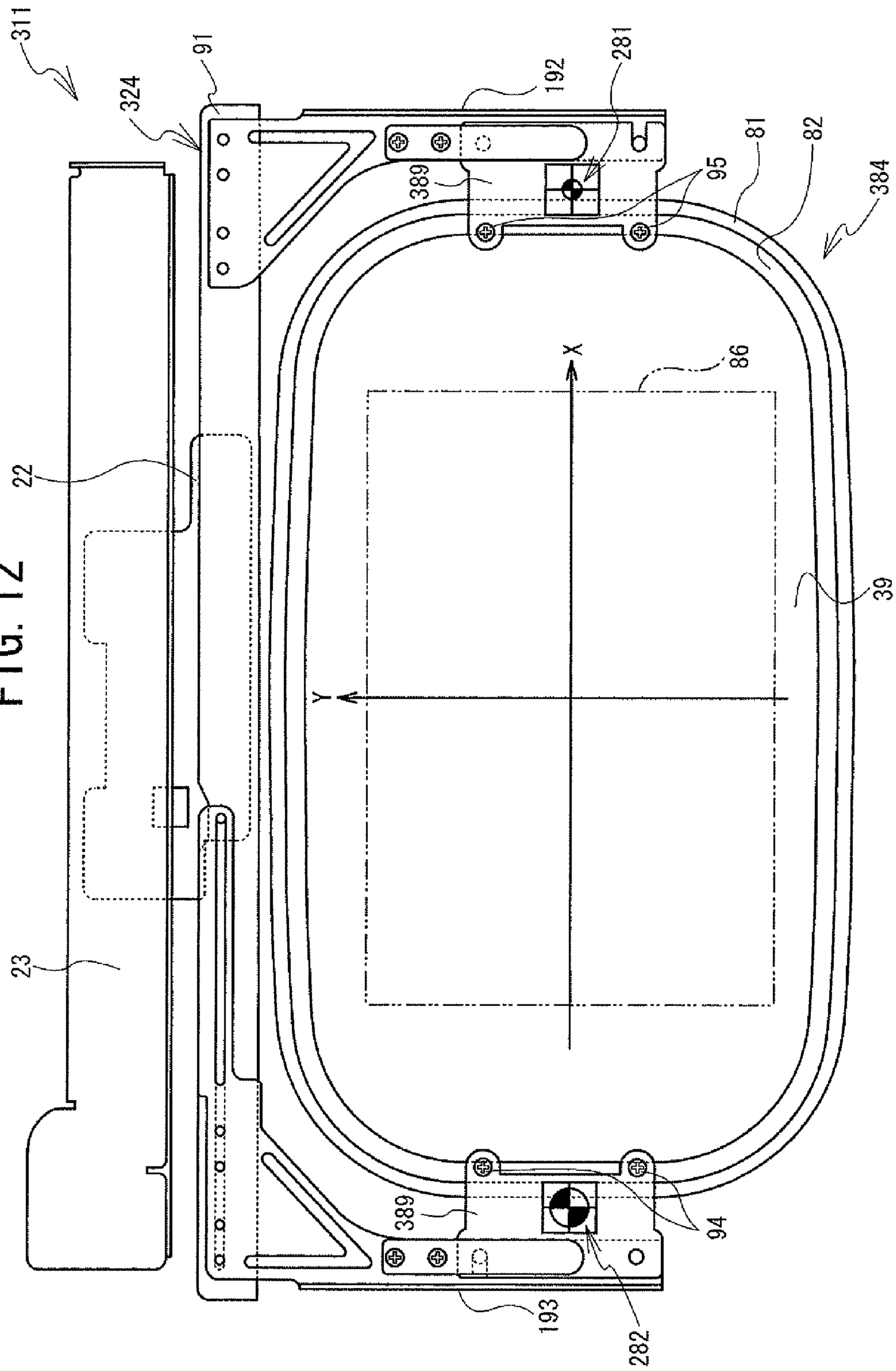


FIG. 11

PARAMETER	DATA
PATTERN ID	202
START	4
END	6
AMOUNT OF MOVEMENT	ΔMx, ΔMy
ANGLE OF ROTATION	ϕ
REFERENCE POSITION	(P1, Q1, R1)
REFERENCE ANGLE	θ

FIG. 12



SEWING MACHINE AND COMPUTER-READABLE MEDIUM STORING SEWING MACHINE CONTROL PROGRAM

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to Japanese Patent Application No. 2009-203648, filed Sep. 3, 2009, the content of which is hereby incorporated herein by reference in its entirety.

BACKGROUND

The present disclosure relates to a sewing machine that is used in a sewing system that performs sewing of a single embroidery pattern using a plurality of sewing machines and to a computer-readable medium that stores a sewing machine control program.

A sewing system is known in which a plurality of multi-needle sewing machines are connected to one another. The known embroidery sewing system includes a plurality of multi-needle sewing machines and performs sewing of a single embroidery pattern using the plurality of multi-needle sewing machines. More specifically, the embroidery sewing system allocates to each of the multi-needle sewing machines a partial pattern that constitutes a portion of the embroidery pattern, such that the number of times that the thread spools are replaced within the embroidery sewing system is reduced and the sewing time is shortened. Each of the multi-needle sewing machines performs sewing of the partial pattern that has been allocated to it.

SUMMARY

In the known sewing system, cases may occur in which the sewing cannot be performed under the same conditions in every one of the sewing machines included in the sewing system. For example, cases may occur in which the attached positions of embroidery frames in relation to embroidery devices with which the sewing machines are provided differ from one sewing machine to the next, due to attaching errors and the like. In a case where the partial patterns are not sewn under the same conditions in every one of the sewing machines, the possibility arises that the relative positions of the partial patterns that are sewn in the different sewing machines will be unintentionally altered and the appearance of the embroidery pattern will be impaired.

Various exemplary embodiments of the broad principles derived herein provide a sewing machine and a computer-readable medium that stores a sewing machine control program that are capable of matching the positions of partial patterns in a case where a single embroidery pattern is sewn using a plurality of sewing machines.

Exemplary embodiments provide a sewing machine that is included in a sewing system that, using a plurality of the sewing machines, performs sewing of a single embroidery pattern on a work cloth that is held by an embroidery frame. The sewing machine includes a transfer device, a sewing device, an image capture device, a communication device, a data computation device, a first control device, a marker data acquisition device, a sewing condition acquisition device, a pattern data acquisition device, a condition computation device, a correction device, and a sewing control device. The transfer device includes a carriage to which the embroidery frame can be attached and that is adapted to transfer the carriage. The sewing device moves a needle bar, to a bottom

end of which a needle is attached, up and down. The image capture device is adapted to capture at least one image of at least one marker that is positioned in a marker area, the marker area being on at least one of the embroidery frame that is attached to the carriage and the work cloth that is held by the embroidery frame. The communication device is adapted to transmit and receive data among the plurality of the sewing machines. The data computation device computes, as first marker data, at least one of a reference position and a reference angle of the at least one marker in relation to the carriage, based on image data that are generated by the image capture device. The first control device transmits the first marker data that are computed by the data computation device, through the communication device, to another sewing machine, among the plurality of the sewing machines, that will be used later than the sewing machine. The marker data acquisition device acquires, as second marker data, through the communication device, the first marker data that are transmitted from another sewing machine among the plurality of the sewing machines. The sewing condition acquisition device acquires a sewing condition that includes a condition for specifying at least one partial pattern among a plurality of partial patterns that form the embroidery pattern as a whole, the at least one partial pattern being allocated to the sewing machine. The pattern data acquisition device acquires pattern data that are data for sewing the at least one partial pattern that is specified by the sewing condition and that is allocated to the sewing machine. The condition computation device computes, as a correction condition, at least one of two differences, the two differences being a difference between a first position and a second position, and a difference between a first angle and a second angle. The first position is the reference position that is included in the first marker data that are computed by the data computation device. The second position is the reference position that is included in the second marker data that are acquired by the marker data acquisition device. The first angle is the reference angle that is included in the first marker data. The second angle is the reference angle that is included in the second marker data. The correction device sets a position and an angle of the at least one partial pattern in relation to the carriage and corrects the pattern data that are acquired by the pattern data acquisition device based on the correction condition that is computed by the condition computation device and on the sewing condition that is acquired by the sewing condition acquisition device. The sewing control device performs the sewing of the at least one partial pattern by controlling the transfer device and the sewing device in accordance with the pattern data that are corrected by the correction device.

Exemplary embodiments also provide a computer-readable medium storing a control program executable on a sewing machine that is included in a sewing system that, using a plurality of the sewing machines, performs sewing of a single embroidery pattern on a work cloth that is held by an embroidery frame. The program includes instructions that cause a controller of the sewing machine to perform the steps of computing, as first marker data, based on image data that are generated by an image capture device that captures at least one image of at least one marker that is positioned in a marker area that is on at least one of the embroidery frame that is removably attached to a carriage and the work cloth that is held by the embroidery frame, in relation to the carriage, at least one of a reference position and a reference angle of the at least one marker, transmitting the computed first marker data, through a communication device that is adapted to transmit and receive data among the plurality of the sewing machines, to another sewing machine, among the plurality of

the sewing machines, that will be used later than the sewing machine, acquiring, as second marker data, through the communication device, the first marker data that are transmitted from another sewing machine among the plurality of the sewing machines, acquiring a sewing condition that includes a condition for specifying at least one partial pattern among a plurality of partial patterns that form the embroidery pattern as a whole, the at least one partial pattern being allocated to the sewing machine, acquiring a setting condition that is a condition for specifying a position and an angle of the embroidery pattern in relation to an initial positioning of the embroidery pattern, acquiring pattern data that are data for sewing the at least one partial pattern that is specified by the sewing condition and that is allocated to the sewing machine, computing, as a correction condition, at least one of two differences, the two differences being a difference between a first position and a second position, and a difference between a first angle and a second angle, the first position being the reference position that is included in the computed first marker data, the second position being the position that is included in the second marker data, the first angle being the reference angle that is included in the first marker data, and the second angle being the reference angle that is included in the second marker data, setting a position and an angle of the partial pattern in relation to the carriage, based on the correction condition and the sewing condition, and correcting the pattern data, and performing the sewing of the partial pattern by controlling, in accordance with the corrected pattern data, a transfer device and a sewing device, the transfer device including the carriage and being adapted to transfer the carriage, and the sewing device being adapted to moving a needle bar, to a bottom end of which a needle is attached, up and down.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments will be described below in detail with reference to the accompanying drawings in which:

FIG. **1** is a conceptual diagram of a sewing system **100** that is provided with a plurality of multi-needle sewing machines **1**;

FIG. **2** is an oblique view of the multi-needle sewing machine **1**;

FIG. **3** is an oblique view that shows an interior of a needle bar case **21**;

FIG. **4** is a plan view of an embroidery frame moving mechanism **11**;

FIG. **5** is a block diagram that shows an electrical configuration of the multi-needle sewing machine **1**;

FIG. **6** is an explanatory figure of a marker **180**;

FIG. **7** is an explanatory figure of a sewing screen **200** that is displayed on a liquid crystal display **7**;

FIG. **8** is a flowchart of main processing;

FIG. **9** is an explanatory figure of processing that detects the marker **180** based on image data of the marker **180** that are captured and acquired;

FIG. **10** is an explanatory figure of the processing that detects the marker **180** based on the image data of the marker **180** that are captured and acquired;

FIG. **11** is an explanatory figure of history data;

FIG. **12** is a plan view of an embroidery frame moving mechanism **311** in a modified embodiment;

DETAILED DESCRIPTION

Hereinafter, a multi-needle sewing machine (hereinafter simply called the sewing machine) **1** that is an embodiment will be explained with reference to the drawings. The referenced drawings are used for explaining technical features that may be utilized in the present disclosure, and the device configurations and the like that are described are simply explanatory examples that do not limit the present disclosure to only those configurations and the like.

First, a sewing system **100** will be explained with reference to FIG. **1**. The sewing system **100** includes two sewing machines **1**. The two sewing machines **1** are connected by a USB cable **147** that is connected to connectors **9** that will be described later (refer to FIGS. **2** and **5**). The physical configurations and the electrical configurations are the same between the two sewing machines **1**.

The physical configuration of the sewing machine **1** will be explained with reference to FIGS. **2** and **3**. In the explanation that follows, in FIG. **2**, the lower left side, the upper right side, the upper left side, and the lower right side of the page respectively indicate the front side, the rear side, the left side, and the right side of the sewing machine **1**.

The sewing machine **1** is provided with a supporting portion **2**, a pillar **3**, and an arm **4**. The supporting portion **2** is formed in an inverted U shape in a plan view, and the supporting portion **2** supports the entire sewing machine **1**. A pair of left and right guide slots **25** that extend in the front-to-rear direction are provided on the top face of the supporting portion **2**. The pillar **3** is provided such that it rises upward from the rear portion of the supporting portion **2**. The arm **4** extends forward from the upper end of the pillar **3**. A needle bar case **21** is mounted on the front end of the arm **4** such that the needle bar case **21** can move to the left and to the right. The needle bar case **21** will be described in detail later.

An operation portion **6** is provided on the right side of the arm **4** at a central position in the front-to-rear direction. A vertically extending shaft (not shown in the drawings) serves as an axis of rotation on which the operation portion **6** is pivotally supported by the arm **4**. The operation portion **6** is provided with a liquid crystal display (hereinafter simply called the LCD) **7**, a touch panel **8**, and connectors **9**. An operation screen for a user to input commands, for example, may be displayed on the LCD **7**. The touch panel **8** may be used to accept commands from the user. The user can select various types of conditions relating to a sewing pattern and sewing by using a finger, stylus pen or the like to perform a pressing operation (the operation hereinafter being called a panel operation) on a location on the touch panel **8** that corresponds to a position on a screen that is displayed on the LCD **7** and that shows an input key or the like. The connectors **9** are USB standard connectors, and a USB device **160** (refer to FIG. **5**) can be connected to them.

A cylindrical cylinder bed **10** that extends forward from the bottom end of the pillar **3** is provided underneath the arm **4**. A shuttle (not shown in the drawings) is provided in the interior of the front end of the cylinder bed **10**. A bobbin (not shown in the drawings) on which a lower thread (not shown in the drawings) is wound may be accommodated in the shuttle. A shuttle drive mechanism (not shown in the drawings) is also provided in the interior of the cylinder bed **10**. The shuttle drive mechanism rotationally drives the shuttle. A needle plate **16** that is rectangular in a plan view is provided on the top face of the cylinder bed **10**. A needle hole **36** through which a needle **35** passes is provided in the needle plate **16**.

An embroidery frame moving mechanism **11** is provided underneath the arm **4**. The sewing machine **1** performs sewing of an embroidery pattern on a work cloth **39** that is held by an embroidery frame **84** as the embroidery frame **84** is moved to the left and the right, and forward and backward, by an X axis motor **132** (refer to FIG. **5**) and a Y axis motor **134** (refer to

FIG. **5**) of the embroidery frame moving mechanism **11**. The embroidery frame moving mechanism **11** will be described in detail later.

A right-left pair of spool platforms **12** are provided at the rear face side of the top face of the arm **4**. Three thread spool pins **14** are provided on each of the spool platforms **12**. The thread spool pins **14** are pins that extend in the vertical direction. The thread spool pins **14** support thread spools **13**. The number of the thread spools **13** that can be placed on the one pair of the spool platforms **12** is six, the same as the number of needle bars **31**. Upper threads **15** may be supplied from the thread spools **13** that are attached to the spool platforms **12**. Each of the upper threads **15** may be supplied, through a thread guide **17**, a tensioner **18**, and a thread take-up lever **19**, to an eye (not shown in the drawings) of each of the needles **35** that are attached to the bottom ends of the needle bars **31** respectively.

Next, an internal mechanism of the needle bar case **21** will be explained with reference to FIG. **3**. As shown in FIG. **3**, the six needle bars **31** that extend in the vertical direction are provided inside the needle bar case **21** at equal intervals X in the left-right direction. A needle bar number is assigned to each of the needle bars **31** in order to identify the individual needle bars **31**. In the present embodiment, the needle bar numbers **1** to **6** are assigned in order starting from the right side in FIG. **3**. The needle bars **31** are supported by two upper and lower securing members (not shown in the drawings) that are secured to a frame **80** of the needle bar case **21**, such that the needle bars **31** can slide up and down. A needle bar follow spring **72** is provided on the upper half of each of the needle bars **31**, and a presser spring **73** is provided on the lower half of each of the needle bars **31**. A needle bar guide **79** is provided between the needle bar follow spring **72** and the presser spring **73**, and a presser guide **83** is provided below the presser spring **73**. The needle bars **31** are slid up and down by a needle bar drive mechanism **85**. The needle bar drive mechanism **85** includes a sewing machine motor **122** (refer to FIG. **5**), a thread take-up lever drive cam **75**, a coupling member **76**, a transmitting member **77**, a guide bar **78**, and a coupling pin (not shown in the drawings). The sewing machine motor **122** is a drive source for the needle bar drive mechanism **85**. The needles **35** (refer to FIG. **2**) may be attached to the bottom ends of the needle bars **31**. A presser foot **71** that extends from each of the presser guides **83** to slightly below the bottom end portion (the tip portion) of the corresponding needle **35**, and operates in conjunction with the up-and-down movement of the corresponding needle bar **31**, the presser foot **71** intermittently presses the work cloth **39** (refer to FIG. **2**) downward.

An image sensor holding mechanism **150** is attached to the lower portion of the right side face of the frame **80**. The image sensor holding mechanism **150** is provided with an image sensor **151**, a holder **152**, a supporting member **153**, and a connecting plate **154**. The image sensor **151** is a known complementary metal oxide semiconductor (CMOS) image sensor. The holder **152** supports the image sensor **151** in a state in which a lens (not shown in the drawings) of the image sensor **151** faces downward. The center of the lens of the image sensor **151** is in a position that is at a distance 2× from the needle bar **31** that is the farthest to the right. The supporting member **153** has an L shape when viewed from the front, and the supporting member **153** supports the connecting plate **154** and the holder **152**. The supporting member **153** is secured to the lower portion of the right side face of the frame **80** by screws **156**. The holder **152** is secured to the bottom face of the supporting member **153** by a screw **157**. The connecting plate **154** is a plate that is L-shaped when viewed from the front, and the connecting plate **154** electrically connects the image sensor **151** to a control portion **140** that will be described later (refer to FIG, **5**). The connecting plate **154** is secured to the front face of the supporting member **153** by screws **155**. The front face, the top face, and the right side face of the image sensor holding mechanism **150** are covered by a cover **38** (refer to FIG. **2**).

A plate **41**, which extends in the right-to-left direction, is affixed to the rear edge of the upper portion of the frame **80**. Eight engaging rollers **42** are respectively mounted on the plate **41** from the rear side by shoulder bolts **44**. Each of the engaging rollers **42** has a round cylindrical shape that is not shown in detail in the drawings. The engaging rollers **42** are supported by shoulder bolts **44** such that the engaging rollers **42** may revolve and such that the engaging rollers **42** cannot move in the axial direction of the engaging rollers **42**. The shoulder bolts **44** are threaded into threaded holes (not shown in the drawings) in the plate **41** and secured. The tips of the shoulder bolts **44** (the tips of male threaded portions) are secured by nuts **43** such that the shoulder bolts **44** will not be loosened by the revolving of the engaging rollers **42**. The intervals between the central axis lines of the engaging rollers **42** are all the same as the intervals X between the needle bars **31**. The heights of mounted positions of the eight engaging rollers **42** are all the same. One of the eight engaging rollers **42** engages a helical cam (not shown in the drawings) that is provided in front portion of the arm **4**. The helical cam is rotated by a needle bar case motor **45** (refer to FIG. **5**) and moves the frame **80** (the needle bar case **21**) to the left and to the right. The one of the needle bars **31** with the needle bar numbers **1** to **6** and the image sensor **151** that corresponds to the engaging roller **42** that engages the helical cam is positioned directly above the needle hole **36**. However, in a case where the engaging roller **42** that is the second from the right has engaged the helical cam, neither any of the needle bars **31** nor the image sensor **151** is positioned directly above the needle hole **36**.

Next, the embroidery frame **84** and the embroidery frame moving mechanism **11** will be explained with reference to FIG. **4**. The embroidery frame **84** is provided with an outer frame **81**, an inner frame **82**, and a pair of left and right coupling portions **89**. The embroidery frame **84** holds the work cloth **39** between the outer frame **81** and the inner frame **82**. The coupling portions **89** are plate members that, in a plan view, have rectangular shapes in which rectangular center portions have been cut out. One of the coupling portions **89** is secured to the right portion of the inner frame **82** by screws **95**, and the other of the coupling portions **89** is secured to the left portion of the inner frame **82** by screws **94**. In addition to the embroidery frame **84**, a plurality of types of other embroidery frames that differ in both size and shape can also be mounted in the sewing machine **1**. Of the embroidery frames that can be used in the sewing machine **1**, the embroidery frame **84** is the embroidery frame with the greatest width in the left-right direction (the distance between the left and right coupling portions **89**). A sewing area **86** is defined in a position that is inside the inner frame **82**, in accordance with the type of the embroidery frame **84**.

The embroidery frame moving mechanism **11** includes a holder **24**, an X carriage **22**, an X axis drive mechanism (not shown in the drawings), a Y carriage **23**, and a Y axis drive mechanism (not shown in the drawings). The holder **24** supports the embroidery frame **84** such that the embroidery frame **84** can be mounted and removed. The holder **24** is provided with an attaching portion **91**, a right arm portion **92**, and a left arm portion **93**. The attaching portion **91** is a plate member that is rectangular in a plan view, with its long sides

running in the left-right direction. The right arm portion **92** is a plate member that extends in the front-rear direction and is secured to the right end of the attaching portion **91**. The left arm portion **93** is a plate member that extends in the front-rear direction. The left arm portion **93** is secured to the left portion of the attaching portion **91** in a position that can be adjusted in the left-right direction in relation to the attaching portion **91**. The right arm portion **92** is engaged with one of the coupling portions **89**, and the left arm portion **93** is engaged with the other of the coupling portions **89**.

The X carriage **22** is a plate member, with its long dimension running in the left-right direction, and a portion of the X carriage **22** projects forward from the front end of the Y carriage **23**. The attaching portion **91** of the holder **24** is attached to the X carriage **22**. The X axis drive mechanism includes the X axis motor **132** (refer to FIG. **5**) and a linear movement mechanism (not shown in the drawings). The X axis motor **132** is a stepping motor. The linear movement mechanism includes a timing pulley (not shown in the drawings) and a timing belt (not shown in the drawings), and the linear movement mechanism moves the X carriage **22** to the left and to the right (in the X axis direction) using the X axis motor **132** as its drive source.

The Y carriage **23** has a box shape, with its long dimension running in the left-right direction. The Y carriage **23** supports the X carriage **22** such that the X carriage **22** can move to the left and to the right. The Y axis drive mechanism includes a pair of left and right moving bodies **26** (refer to FIG. **2**), the Y axis motor **134** (refer to FIG. **5**), and a linear movement mechanism (not shown in the drawings). The moving bodies **26** are coupled to the bottom portions of the left and right ends of the Y carriage **23** respectively and pass vertically through the guide slots **25** (refer to FIG. **2**). The Y axis motor **134** is a stepping motor. The linear movement mechanism includes a timing pulley (not shown in the drawings) and a timing belt (not shown in the drawings), and the linear movement mechanism moves the moving bodies **26** forward and backward (in the Y axis direction) along the guide slots **25** using the Y axis motor **134** as its drive source. In conjunction with these movements, the Y carriage **23**, which is coupled to the moving bodies **26**, and the X carriage **22**, which is supported by the Y carriage **23**, move forward and backward (in the Y axis direction).

Next, the operation that forms a stitch on the work cloth **39** that is held by the embroidery frame **84** will be explained with reference to FIGS. **2** to **5**. The embroidery frame **84** by which the work cloth **39** is held is supported by the holder **24** of the embroidery frame moving mechanism **11** (refer to FIGS. **2** and **4**). First, one of the six needle bars **31** is selected by the moving of the needle bar case **21** in the left-right direction. The embroidery frame **84** is moved to a specified position by the embroidery frame moving mechanism **11**. The needle bar drive mechanism **85** is driven when a main shaft **74** is rotated by the sewing machine motor **122**. The rotational movement of the main shaft **74** is transmitted to the coupling member **76** through the thread take-up lever drive cam **75**, and the transmitting member **77**, on which the coupling member **76** is pivotably supported, is driven up and down, being guided by the guide bar **78**, which is positioned parallel to the needle bar **31**. The up-and-down movement is transmitted to the needle bar **31** through the coupling pin (not shown in the drawings), and the needle bar **31**, to which the needle **35** is attached, is driven up and down. Through a link mechanism that is not shown in detail in the drawings, the thread take-up lever **19** is driven up and down by the rotation of the thread take-up lever drive cam **75**. Furthermore, the rotation of the main shaft **74** is transmitted to the shuttle drive mechanism (not shown in the drawings), and the shuttle (not shown in the drawings) is rotationally driven. Thus the needle **35**, the thread take-up lever **19**, and the shuttle are driven in synchronization, and a stitch is formed on the work cloth **39**.

Next, the electrical configuration of the sewing machine **1** will be explained with reference to FIG. **5**. As shown in FIG. **5**, the sewing machine **1** includes a needle drive portion **120**, a sewn object drive portion **130**, the operation portion **6**, the image sensor **151**, and the control portion **140**. The needle drive portion **120**, the sewn object drive portion **130**, the operation portion **6**, and the control portion **140** will each be described in detail below.

The needle drive portion **120** includes the sewing machine motor **122**, a drive circuit **121**, the needle bar case motor **45**, a drive circuit **123**, a cutting mechanism **126**, and a drive circuit **125**. The sewing machine motor **122** moves the needle bars **31** reciprocally up and down. The drive circuit **121** drives the sewing machine motor **122** in accordance with a control signal from the control portion **140**. The needle bar case motor **45** moves the needle bar case **21** to the left and to the right in relation to the body of the sewing machine **1**. The drive circuit **123** drives the needle bar case motor **45** in accordance with a control signal from the control portion **140**. The cutting mechanism **126** cuts the upper threads **15** (refer to FIG. **2**) that are supplied to the needles **35**. The drive circuit **125** drives the cutting mechanism **126** in accordance with a control signal from the control portion **140**.

The sewn object drive portion **130** includes the X axis motor **132**, a drive circuit **131**, the Y axis motor **134**, and a drive circuit **133**. The X axis motor **132** moves the embroidery frame **84** (refer to FIG. **2**) to the left and to the right. The drive circuit **131** drives the X axis motor **132** in accordance with a control signal from the control portion **140**. The Y axis motor **134** moves the embroidery frame **84** forward and backward. The drive circuit **133** drives the Y axis motor **134** in accordance with a control signal from the control portion **140**.

The operation portion **6** includes the touch panel **8**, the connectors **9**, a drive circuit **135**, and the LCD **7**. The drive circuit **135** drives the LCD **7** in accordance with a control signal from the control portion **140**. The connectors **9** are provided with functions that connect to the USB device **160**. The USB device **160** may be a personal computer, a USB memory, or another sewing machine **1**, for example.

The control portion **140** includes a CPU **141**, a ROM **142**, a RAM **143**, an EEPROM **144**, and an input/output interface (I/O) **146**, all of which are connected to one another by a bus **145**. The needle drive portion **120**, the sewn object drive portion **130**, the operation portion **6**, and the image sensor **151** are each connected to the I/O **146**. The CPU **141**, the ROM **142**, the RAM **143**, and the EEPROM **144** will be explained in detail below.

The CPU **141** conducts main control over the sewing machine **1** and, in accordance with various types of programs that are stored in a program storage area (not shown in the drawings) in the ROM **142**, executes various types of computations and processing that relating to sewing. The programs may also be stored in an external storage device such as a flexible disk or the like.

The ROM **142** is provided with a plurality of storage areas that include the program storage area and a pattern storage area, although these are not shown in the drawings. Various types of programs for operating the sewing machine **1**, including a main program, are stored in the program storage area. The main program is a program for executing main processing that will be described later. Embroidery data (pattern data) for sewing embroidery patterns (partial patterns)

are stored in the pattern storage area in association with pattern IDs. The pattern IDs are used in processing that specifies an embroidery pattern.

The RAM **143** is a storage element that can be read from and written to as desired, and storage areas that store computation results and the like from computational processing by the CPU **141** are provided in the RAM **143** as necessary. The EEPROM **144** is a storage element that can be read from and written to as desired, and various types of parameters for the sewing machine **1** to execute various types of processing are stored in the EEPROM **144**. IDs for distinguishing the sewing machines **1** that are included in the sewing system **100** are also stored in the EEPROM **144**. The IDs can be assigned as desired and may be represented in the form of ten-digit manufacturing numbers, for example. In the present embodiment, the ID of the sewing machine **1** on the left side of FIG. **1** (hereinafter called the first sewing machine **1**) is 1000, and the ID of the sewing machine **1** on the right side of FIG. **1** (hereinafter called the second sewing machine **1**) is 1100.

Next, a marker **180** will be explained with reference to FIG. **6**. The left, right, up, and down directions in FIG. **6** respectively correspond to the left, right, up, and down directions in the marker **180**. The marker **180** may be affixed onto the top surface of the work cloth **39**. The marker **180** that is shown in FIG. **6** is a thin, transparent base material sheet **96** that is rectangular in shape and measures three centimeters long by two centimeters wide. A pattern is drawn on one surface of the base material sheet **96**. Specifically, a first circle **101** and a second circle **102** are drawn on the base material sheet **96**. The second circle **102** is disposed above the first circle **101** and has a smaller diameter than does the first circle **101**. Line segments **103** to **105** are also drawn on the base material sheet **96**. The line segment **103** is a line segment that extends from the top edge to the bottom edge of the marker **180** and passes through a center **110** of the first circle **101** and a center **111** of the second circle **102**. The line segment **104** is a line segment that is orthogonal to the line segment **103** and passes through the center **110** of the first circle **101**, extending from the right edge to the left edge of the marker **180**. The line segment **105** is a line segment that is orthogonal to the line segment **103** and passes through the center **111** of the second circle **102**, extending from the right edge to the left edge of the marker **180**.

Of the four areas that are bounded by the perimeter of the first circle **101**, the line segment **103** and the line segment **104**, an upper right area **108** and a lower left area **109** are filled in with black, and a lower right area **113** and an upper left area **114** are filled in with white. Similarly, of the four areas that are bounded by the second circle **102**, the line segment **103** and the line segment **105**, an upper right area **106** and a lower left area **107** are filled in with black, and a lower right area **115** and an upper left area **116** are filled in with white. All other parts of the surface on which the pattern of the marker **180** is drawn are transparent.

The back surface of the marker **180** (the surface on which the pattern is not drawn) is coated with a transparent adhesive. When the marker **180** is not in use, a release paper (not shown in the drawings) is affixed to the back surface of the marker **180**. The user may peel the marker **180** off the release paper and affixes the marker **180** onto a marker area of the work cloth **39**. The marker area is a position onto which the marker **180** is affixed. The marker area may be anywhere, as long as the marker area is on at least one of the embroidery frame **84** that is attached to the X carriage **22** and the work cloth **39** that is held by the embroidery frame **84**. A predetermined position for the marker area may also be set, and the position may be set anywhere that is on at least one of the embroidery frame **84** that is attached to the X carriage **22** and the work cloth **39** that is held by the embroidery frame **84**. In the present embodiment, a marker area **87** and a marker area **88** that are shown in FIG. **4** are set as the marker areas. The marker area **87** is set in a position that is adjacent to the coupling portion **89** on the left side, in an area between the inner frame **82** and the sewing area **86**, with its position in the front-to-rear direction being between the two screws **94**. The marker area **88** is set in a position that is adjacent to the coupling portion **89** on the right side, in an area between the inner frame **82** and the sewing area **86**, with its position in the front-to-rear direction being between the two screws **95**.

Next, the main processing that is executed in the sewing machine **1** included in the sewing system **100** will be explained using as an example a case in which an embroidery pattern **202** that is shown in FIG. **7** is sewn. First, the embroidery pattern **202** will be explained with reference to FIG. **7**. The embroidery pattern **202** is a pattern of a bird that is to be sewn using threads of six different colors. The embroidery pattern **202** includes partial patterns that are divided according to the thread color, that is, six partial patterns. The embroidery data for the embroidery pattern **202** include six pieces of pattern data. The pattern data are data for sewing the partial patterns. The embroidery pattern **202** is displayed in a pattern display area **201** on a sewing screen **200** that is displayed on the LCD **7**. The order in which the partial patterns are sewn is displayed in a sewing order display area **204**. As shown in the sewing order display area **204**, the partial patterns for the embroidery pattern **202** are supposed to be sewn in the order of white, blue, yellow, orange, red, and black. In a case where the embroidery pattern **202** will be sewn using the one sewing machine **1** that is displaying the sewing screen **200**, the colors of threads of the thread spools that should be attached to the sewing machine **1** are displayed in a thread spool display area **203** in association with the numbers of the needle bars **31**. The embroidery data (the pattern data) for the embroidery pattern **202** may be stored in one of the ROM **142**, the EEPROM **144**, and the USB device **160**, for example. The embroidery data (the pattern data) may also be acquired through an Internet connection, for example.

Next, the embroidery data (the pattern data) of the present embodiment will be explained. The embroidery data (the pattern data) of the present embodiment include data on coordinates in an embroidery coordinate system. The embroidery coordinate system is the coordinate system for the X axis motor **132** and the Y axis motor **134** that move the X carriage **22**. The coordinate data in the embroidery coordinate system describe the position and angle of the embroidery pattern (the partial pattern) in relation to the X carriage **22**. In the present embodiment, the embroidery coordinate system is made to correspond to the actual three-dimensional coordinate system (the world coordinate system) in advance. In the embroidery coordinate system, the left-right direction of the sewing machine **1** is an X axis direction, and the front-rear direction of the sewing machine **1** is a Y axis direction. In the present embodiment, in a case where the embroidery frame **84** is properly attached to the X carriage **22**, the theoretical center of the sewing area **86** serves as an origin point (X, Y, Z)=(0, 0, 0) at a position that is congruent with a needle drop point. The needle drop point is the point where the needle **35** pierces the work cloth **39** when the corresponding needle bar **31** is moved downward from a state in which the needle **35** that is disposed directly above the needle hole **36** (refer to FIG. **2**) is above the work cloth **39**. In the present embodiment, the embroidery frame moving mechanism **11** does not move the X carriage **22** in a Z direction (the up-down direction of the sewing machine

1), so as long as the thickness of the work cloth **39** can be ignored, the top surface of the work cloth **39** is deemed to have a Z coordinate value of zero.

Next, an overview of the main processing that is executed in the sewing system **100** will be explained. In the main processing, the partial pattern that is allocated to the sewing machine **1** is sewn in the sewing order. Using the panel operation, the user may select the embroidery pattern, modify the placement of the selected embroidery pattern, and allocate the partial patterns. The user may allocate the partial patterns to the individual sewing machines **1**, taking into account the colors of the threads of the thread spools **13** that are attached to the individual sewing machines **1**, The main processing may be started in any one of the sewing machines **1** included in the sewing system **100**. The sewing machine **1** in which the main processing is started by an instruction from the user transmits a start command to the other sewing machine **1** included in the sewing system **100**. When the other sewing machine **1** receives the start command, the other sewing machine **1** starts the main processing. In other words, once the main processing is started in any one of the sewing machines **1**, the main processing is executed in all of the sewing machines **1** included in the sewing system **100**. As shown in FIG. **1**, the colors of the threads of the thread spools **13** that are attached to the first sewing machine **1** are white, black, green, blue, sky blue, and yellow. The colors of the threads of the thread spools **13** that are attached to the second sewing machine **1** are greenish yellow, sky blue, red, orange, blue, and black. In the main processing, the positioning of the embroidery pattern (the partial pattern) is determined in the first sewing machine **1** that will be used, based on a sewing condition. The sewing condition is a condition that includes at least a pattern condition that is a condition for specifying at least one partial pattern, among the plurality of the partial patterns that form the embroidery pattern as a whole, that is allocated to the sewing machine **1**. In the present embodiment, the sewing condition includes a setting condition in addition to the pattern condition. The setting condition is a condition for specifying the setting of the positioning of the embroidery pattern. In the present embodiment, the setting condition specifies a position and an angle of the embroidery pattern in relation to an initial positioning of the embroidery pattern. Therefore, in the main processing, the positioning of the embroidery pattern (the partial pattern) is determined in the first sewing machine **1** that will be used, based on the pattern data which are specified by the pattern condition, and on the setting condition. In the sewing machines **1** that will be used second and later, the positioning of the embroidery pattern (the partial pattern) is determined based on the pattern data and the setting condition, as well as correction condition that is computed based on first and second marker data.

Next, the main processing in the sewing system **100** will be explained in more detail with reference to FIG. **8**. The main processing in FIG. **8** is executed by the CPU **141** in accordance with the main program that is stored in the ROM **142**. A case in which the main processing is started in the first sewing machine **1** will be explained as an example.

First, a determination is made as to whether history data have been received (Step S**5**). The history data are data that are transmitted through the USB cable **147** from the sewing machine **1** that is used before the sewing machine **1** in interest (for example, the first sewing machine **1**). The history data will be described in detail later. The processing in a case where the history data have been received (YES at Step S**5**) will be described later.

In a case where the history data have not been received (NO at Step S**5**), a determination is made as to whether the pattern condition has been input (Step S**10**). In the present embodiment, assume information is input on the sewing machine **1** that will be the first to be used in order to specify the partial patterns that are allocated to each of the sewing machines **1** that will be used for sewing the embroidery pattern. Specifically, at Step S**10**, a condition that includes both the pattern ID that specifies the embroidery pattern and the information that specifies the partial patterns that will be allocated to each of the sewing machines **1** are input as the pattern condition on the sewing machine **1** that will be the first to be used. Therefore, the pattern condition that is input at Step S**10** includes a condition for specifying the partial patterns that will be allocated to the sewing machine **1** that will be the first to be used and a condition for specifying the partial patterns that will be allocated to the other sewing machine **1**. At Step S**10**, in a case where both the pattern ID that specifies the embroidery pattern and the information that specifies the partial patterns that will be allocated to each of the sewing machines **1** included in the sewing system **100** have been input by the panel operation, a determination is made that the pattern condition has been input (YES at Step S**10**). In a case where the pattern condition has not been input (NO at Step S**10**), the processing returns to Step S**5**. In the processing at Step S**10**, assume a specific example in which the pattern ID of the embroidery pattern **202** in FIG. **7** has been input as the pattern ID. In this specific example, it is assumed that the first to the third partial patterns in the sewing order have been allocated to the first sewing machine **1** and that the fourth to the sixth partial patterns in the sewing order have been allocated to the second sewing machine **1**. In a case where the pattern condition has been input (YES at Step S**10**), the pattern condition that has been input is acquired, and the acquired pattern condition is stored in the RAM **143** (Step S**15**).

Next, the pattern data are acquired from the ROM **142** in accordance with the condition that specifies at least one of the partial patterns that have been allocated to the sewing machine **1** in interest and that is included in the pattern condition that has been acquired at Step S**15**. The acquired pattern data are stored in the RAM **143** (Step S**20**). At Step S**20**, in the case of the specific example that is described above, the pattern data that are acquired in the first sewing machine **1** correspond to the first to the third partial patterns in the sewing order of the embroidery pattern **202**. Next, a determination is made as to whether the positioning of the embroidery pattern has been changed (Step S**25**). A command to change the positioning may be input by the panel operation. In the present embodiment, the sewing machine **1** is capable of changing the settings for the position and the angle of the embroidery pattern, which are expressed in the embroidery coordinate system, in relation to the initial positioning. In a case where the positioning of the embroidery pattern has been changed (YES at Step S**25**), an amount of movement (ΔMx, ΔMy) of a reference point in relation to the initial positioning and an angle of rotation ϕ of the embroidery pattern expressed in the embroidery coordinate system are acquired as a setting condition, and the acquired setting condition is stored in the RAM **143** (Step S**30**). The initial positioning of the embroidery pattern is defined by the coordinate data in the pattern data that have been acquired at Step S**20**. The reference point is determined as appropriate, and a hypothetical point that coincides with the origin point prior to the change in the positioning may be used, for example. The angle of rotation ϕ expresses, as a positive value, the angle in a case where the embroidery pattern has been rotated counterclockwise around the reference point. At Step S**30**, assume a specific example in which, after the embroidery pattern **202** has been rotated fifteen degrees counterclockwise around the origin

point, the embroidery pattern **202** is moved 25 units in the positive direction of the X axis and 25 units in the positive direction of the Y axis. In this specific example, the amount of movement (ΔMx, ΔMy) of the hypothetical point is acquired as (25, 25), and the angle of rotation ϕ is acquired as fifteen degrees.

Next, the pattern data are corrected, and the corrected pattern data are stored in the RAM **143** (Step S**35**). At Step S**35**, the pattern data that have been acquired at Step S**20** are corrected based on the setting condition that has been acquired at Step S**30**. The coordinate data that are included in the pattern data are defined as (x, y). The coordinate data (x, y) are corrected based on the setting condition, and coordinate data (x', y') are computed by the correcting processing. In a case where the previously described hypothetical point is defined as the reference point, the coordinate data (x', y') are computed based on the equation (x', y')=(x cos ϕ−y sin ϕ+ΔMx, x sin ϕ+y cos ϕ+ΔMy).

In a case where the positioning has not been changed (NO at Step **525**), as well as a step following Step S**35**, a determination is made as to whether a command to start the sewing has been input (Step S**40**). The command to start the sewing may be input by the panel operation, for example. In a case where the command to start the sewing has not been input (NO at Step S**40**), the CPU **141** waits until the command to start the sewing is input. In a case where the command to start the sewing has been input (YES at Step S**40**), the at least one partial pattern is sewn in accordance with the pattern data (Step S**45**). In a case where, the positioning of the embroidery pattern **202** has not been changed (NO at Step S**25**), the partial pattern is sewn based on the pattern data that have been acquired at Step S**20**. In a case where, at Step S**25**, the positioning of the embroidery pattern **202** has been changed (YES at Step S**25**), the partial pattern is sewn based on the pattern data that have been corrected at Step S**35**. Specifically, a control signal is output to the drive circuit **123** in accordance with the pattern data, and the needle bar case motor **45** is driven. This causes the needle **35** to which thread of the thread spool **13** (refer to FIG. **2**) is supplied that has the color that corresponds to the pattern data to be positioned directly above the needle hole **36**. Control signals are also output to the drive circuit **131** and the drive circuit **133** in accordance with the pattern data, and the embroidery frame **84** is moved. A control signal is also output to the drive circuit **121**, and the sewing machine motor **122** is driven. This causes the needle bar **31** that is positioned directly above the needle hole **36** to move in the up and down directions. The processing at Step S**45** causes the first to the third partial patterns in the sewing order to be sewn by the first sewing machine **1**. The thread spools **13** for the first to the third thread colors in the sewing order (white, blue, yellow) have been attached to the first sewing machine **1**. Therefore, at Step S**45**, the sewing is performed continuously, without interruption, with the threads being switched for the first to the third partial patterns in the sewing order.

Next, a message screen is displayed on the LCD **7** (Step S**50**). A message is displayed on the message screen that prompts the user to input an image capture command after checking the following item. The item that is displayed on the LCD **7** is whether the markers **180** have been affixed onto the marker area **87** and the marker area **88**. The positions of the marker area **87** and the marker area **88** are displayed on the message screen along with a schematic view of the embroidery frame **84** (not shown in the drawings). The user checks the message screen and attached the markers **180** onto the marker area **87** and the marker area **88**.

Following the processing at Step S**50**, the CPU **141** waits for the image capture command to be input (NO at Step S**55**), and in a case where the image capture command is input (YES at Step S**55**), the image sensor **151** captures images of the markers **180** that are affixed onto the marker area **87** and the marker area **88**, respectively (Step S**60**). The image capture command may be input by the panel operation, for example. At Step S**60**, a control signal is output to the drive circuit **123** (refer to FIG. **5**), and the needle bar case **21** is moved to the position where the helical cam (not shown in the drawings) engages the engaging roller **42** that is the farthest to the right. The image sensor **151** is positioned directly above the needle hole **36** by the moving of the needle bar case **21**. Next, control signals are output to the drive circuit **131** (refer to FIG. **5**) and the drive circuit **133** (refer to FIG. **5**), and the embroidery frame **84** is moved in accordance with the embroidery coordinate system coordinates of the marker area **87** that are stored in the EEPROM **144**. The marker area **87** is moved to a position directly below the image sensor **151** by the moving of the embroidery frame **84**. Next, an image of the marker **180** that is positioned in the marker area **87** is captured by the image sensor **151**, and the image data that are thus generated are stored in the RAM **143**. In the same manner, an image of the marker **180** that is affixed onto the marker area **88** is captured, and the image data that are thus generated are also stored in the RAM **143**.

Next, first marker data are computed based on the image data that have been generated at Step S**60**, and the computed first marker data is stored in the RAM **143** (Step S**65**). The first marker data are data that represent at least one of the positions and the angles related to the markers **180** in relation to the X carriage **22**. In the present embodiment, the position related to the markers **180** that are described by the coordinates of the embroidery coordinate system (hereinafter called the reference position) and the angle related to the markers **180** in relation to the positive direction on the X axis (hereinafter called the reference angle) are computed as the first marker data.

The method for computing the first marker data in the present embodiment will be explained with reference to FIGS. **9** and **10**. First, two-dimensional coordinates in an image coordinate system are computed for the first circle **101** and the second circle **102** of the marker **180** (refer to FIG. **6**). The image coordinate system is a coordinate system for the image that has been captured by the image sensor **151**. The two-dimensional coordinates in the image coordinate system are computed based on a position in the image. Specifically, circumferences of a circle **161** and a circle **162** are identified in the captured image, as shown in FIG. **9**, for example, by Hough transform processing, which is a known technique. The coordinates of a center **163** of the circle **161** and a center **164** of the circle **162**, and radii of the circle **161** and the circle **162** are computed. At this stage, a circle that is included in a pattern or the like of the work cloth **39** itself may be identified in addition to the first circle **101** and the second circle **102** of the marker **180**. Hereinafter, a number z of coordinates that are computed for a center of a circle are indicated as (a, b) (for example, (a1, b1), (a2, b2), (a3, b3), . . . , (az, bz)), and a radius that is computed for a circle is indicated as r (for example, r1, r2, r3, . . . , rz).

The image data are processed, with Harris operator, for example, which is a known technique, to compute coordinates **171** to **179** and **181** of corners, from the captured image, as shown in FIG. **10**. The corner refers to an intersection point at which a plurality of edges (portions that are each formed of a line, such as a contour) intersect with each other. Hereinaf-

ter, the computed a number 10 of coordinates of the corners are indicated as (s, t) (for example, (s1, t1), (s2, t2), (s3, t3), . . . , (s10, s10)).

Next, the computation results for the coordinates (a, b) and the radii r are compared to the coordinates (s, t). In a case where a set of the coordinates (s, t) exists that coincides with one of the sets of the coordinates (a, b), and sets of the coordinates (s, t) exist that coincide with the coordinates of positions along one of the radii r whose midpoint is at one of the sets of the coordinates (a, b), a determination is made that the first set of the coordinates (s, t) are the coordinates of the center of one of the first circle **101** and the second circle **102** in FIG. **10**, and the other sets of the coordinates (s, t) are the coordinates of points where a line segment intersects the circumference of one of the first circle **101** and the second circle **102**. Of the coordinates (a, b) that are the coordinates of the center of one of the first circle **101** and the second circle **102**, the coordinates that correspond to the center of the circle for which the value of the radius r is greater are identified as the coordinates (p, q) of the center of the first circle **101**. The coordinates that correspond to the center of the circle for which the value of the radius r is smaller are identified as the coordinates (u, v) of the center of the second circle **102**. The executing of the image processing that is described above causes the coordinates (p1, q1) of the center of the first circle **101** and the coordinates (u1, v1) of the center of the second circle **102** to be computed for the marker **180** that is positioned in the marker area **87**. The coordinates (p2, q2) of the center of the first circle **101** and the coordinates (u2, v2) of the center of the second circle **102** in the marker **180** that is positioned in the marker area **88** are computed in the same manner.

Next, three-dimensional coordinate conversion processing is executed on the center coordinates that have been computed. The three-dimensional coordinate conversion processing is processing that converts the two-dimensional coordinates of the image coordinate system into the three-dimensional coordinates of the embroidery coordinate system (the world coordinate system). The three-dimensional coordinate conversion processing may be executed using a known method. For example, Japanese Laid-Open Patent Publication No. 2009-172119 discloses the three-dimensional coordinate conversion processing, the relevant portions of which are herein incorporated by reference. In the three-dimensional coordinate conversion processing, the amount of movement of the embroidery frame **84** at Step S**60** is factored into the computation of the three-dimensional coordinates of the embroidery coordinate system. The execution of the three-dimensional coordinate conversion processing causes the coordinates (P1, Q1, R1) of the center of the first circle **101** and the coordinates (U1, V1, W1) of the center of the second circle **102** to be computed for the marker **180** that is positioned in the marker area **87**. The coordinates (P2, Q2, R2) of the center of the first circle **101** and the coordinates (U2, V2, W2) of the center of the second circle **102** in the marker **180** that is positioned in the marker area **88** are computed in the same manner.

Next, the reference position and the reference angle are computed. The reference position is defined as the coordinates (P1, Q1, R1) of the center of the first circle **101** in the marker **180** that is positioned in the marker area **87**, as expressed in the embroidery coordinate system. The reference angle θ is defined as the angle, in relation to the positive direction on the X axis of the embroidery coordinate system, of a vector from the coordinates (P1, Q1, R1) to the coordinates (P2, Q2, R2) of the center of the first circle **101** in the marker **180** that is positioned in the marker area **88**. As described previously, the embroidery coordinate system is the coordinate system that is defined for moving the X carriage **22**, so the reference position and the reference angle express the position and the angle related to the markers **180** in relation to the X carriage **22**, respectively. The marker **180** that is positioned in the marker area **87** and the marker **180** that is positioned in the marker area **88** are differentiated by taking into consideration the coordinates of the centers of the second circles **102** in relation to the centers of the first circles **101** and the positioning of the markers **180** within the embroidery frame **84**. In the present embodiment, the Z coordinate of a point on the work cloth **39** is defined as having a (fixed) value of zero, so the reference angle θ is computed using the equation $\theta=\tan^{-1}((Q2-Q1)/(P2-P1))$.

Following Step S**65**, the history data are transmitted through the connectors **9** and the USB cable **147** from the sewing machine **1** in interest to the sewing machine **1** that will be used later (Step S**70**). At Step S**70**, first, the second sewing machine **1** is specified as the sewing machine **1** that will be used later, based on the pattern condition that has been acquired at Step S**15**. At Step S**70**, the history data are generated as shown in FIG. **11**, with the history data including the pattern condition that has been acquired at Step S**15**, the setting condition that has been acquired at Step S**30**, and the first marker data that have been computed at Step S**65**. The history data in FIG. **11** include the pattern ID, the START, and the END, as information that specifies the at least one partial pattern that is allocated to the sewing machine **1** that will be received the history data, include the amount of movement (ΔMx, ΔMy) and the angle of rotation ϕ as the setting condition, and include the reference position and the reference angle as the first marker data. In a case where the positioning of the embroidery pattern has not been changed by the processing at Step S**25**, the values (ΔMx, ΔMy) for the amount of movement of the embroidery pattern are set to (0, 0), and the angle of rotation ϕ is set to zero degrees. The history data are transmitted from the first sewing machine **1** to the second sewing machine **1** through the USB cable **147** that is connected to the connectors **9**. Following Step S**70**, the main processing is terminated.

At Step S**5**, in a case where the history data have been received through the connectors **9** and the USB cable **147** (YES at Step S**5**), the received history data are stored in the RAM **143** (Step S**80**). Hereinafter, assume a case in which the main processing is performed in the second sewing machine **1**. In this case, the history data that have been transmitted by the processing at Step S**70** in the first sewing machine I are acquired at Step S**5**. The pattern ID, the START, and the END that are included in the history data are acquired as the pattern condition in the sewing condition. The first marker data that are included in the history data are acquired as the second marker data. The amount of movement (ΔMx, ΔMy) and the angle of rotation ϕ of the embroidery pattern **202** are acquired as the setting condition in the sewing condition. Next, the pattern data are acquired based on the pattern condition in the sewing condition that has been acquired at Step S**80**, and the acquired pattern data are stored in the RAM **143** (Step S**85**). At Step S**85**, the pattern data are acquired for the fourth to the sixth partial patterns in the sewing order of the embroidery pattern **202**. Next, the message screen is displayed on the LCD **7** (Step S**90**). On the message screen, a message is displayed that prompts the user to input the image capture command. Next, the processing at Steps S**95** to S**110** is performed. The processing at Steps S**95** to S**110** is the same as the processing at Steps S**55** to S**65**, so an explanation will be omitted.

Next, the correction condition is computed based on the second marker data that have been acquired at Step S**80** and on the first marker data that have been computed at Step S**110**, and the computed correction condition is stored in the RAM **143** (Step S**115**). The correction condition is a condition for matching the positions of the partial patterns. In the present embodiment, each difference of the reference position and the reference angle related to the markers **180** are computed based on the the first marker data and the second marker data. In the present embodiment, the Z coordinate of a point on the work cloth **39** is defined as having a (fixed) value of zero, so correction of the Z axis component is not performed. If the reference position included in the first marker data (hereinafter called the first position) is defined as (f1, g1, h1), and the reference position in the second marker data (hereinafter called the second position) is defined as (f2, g2, h2), the correction condition for the reference position is the difference between the first position and the second position expressed by the equation $(\Delta mx, \Delta my)=(f2-f1, g2-g1)$. In the same manner, if the reference angle included in the first marker data (hereinafter called the first angle) is defined as $\theta 1$, and the reference angle included in the second marker data (hereinafter called the second angle) is defined as $\theta 2$, the correction condition for the reference angle is the difference between the first angle and the second angle expressed by the equation $\Delta\theta=\theta 2-\theta 1$.

Next, the pattern data that have been acquired at Step S**85** are corrected, and the corrected pattern data are stored in the RAM **143** (Step S**120**). At Step S**120**, the pattern data that have been acquired at Step S**85** are corrected based on the setting condition included in the sewing condition that has been acquired at Step S**80** and on the correction condition that has been computed at Step S**115**. First, the pattern data are corrected in the same manner as at Step S**35**, based on the setting condition that has been acquired at Step S**80**. Here, assume that the coordinate data that are included in the pattern data are defined as (x, y). For example, corrected coordinate data (x', y') are computed based on the equation $(x', y')=(x \cos \phi-y \sin \phi+\Delta Mx, x \sin \phi+y \cos \phi+\Delta My)$ that is used in a case where the previously described hypothetical point is defined as the reference point, in the same manner as at Step S**35**. Next, the coordinate data (x', y') are corrected based on the correction condition that has been computed at Step S**115**, and coordinate data (x", y") are computed by the correcting processing. The coordinate data (x", y") are computed based on the equation $(x'', y'')=((x'-F2) \cos \Delta\theta-(y'-g2) \sin \Delta\theta+F2+\Delta mx, (x'-f2) \sin \Delta\theta+(y'-g2) \cos \Delta\theta+g2+\theta my)$. In a case where the positioning of the embroidery pattern has not been changed, the coordinate data (x", y") may also be computed using (x, y) instead of (x', y').

Next, the CPU **141** waits until the command to start the sewing is input (NO at Step S**125**), in a case where the command to start the sewing has been input (YES at Step S**125**), the fourth to the sixth partial patterns in the sewing order are sewn in accordance with the pattern data that have been corrected at Step S**120** (Step S**130**). The thread spools **13** for the fourth to the sixth thread colors in the sewing order (orange, red, black) have been attached to the second sewing machine **1**. Therefore, at Step S**130**, the sewing is performed continuously, without interruption, with the threads being switched for the fourth to the sixth partial patterns in the sewing order. Next, because the second sewing machine **1** is the last sewing machine **1** that is used (YES at Step S**135**), the processing at Step S**70** is omitted, and the main processing is terminated. In a case where, at Step S**135**, the sewing machine **1** in interest is not the last sewing machine **1** that is used (NO at Step S**135**), the processing at Step S**70** is performed, and then the main processing is terminated.

In the sewing system **100**, the sewing position of the partial pattern in any one of the sewing machines **1** that are used second and later can be set in relation to the X carriage **22** based on the markers **180** that are positioned in the marker area **87** and the marker area **88**. In particular, in the present embodiment, the second sewing machine **1** that is used can use the first marker data that is computed in the second sewing machine and the second marker data that is computed in the first sewing machine **1** to detect the difference in the positions where the embroidery frame **84** is attached and the differences in the settings of the embroidery coordinate system. The second sewing machine **1** that is used then corrects the pattern data such that the detected differences are eliminated. Therefore, even in a case where the positions where the embroidery frame **84** is attached are different between in the first sewing machine **1** and in the second sewing machine **1**, it is possible to avoid a situation in which the relative positioning of the partial patterns that are sewn in the plurality of the sewing machines **1** is unintentionally changed. Accordingly, each of the sewing machines **1** included in the sewing system **100** can accurately sew the embroidery pattern **202** together with the other sewing machines **1**. Because the sewing machine **1** uses the two markers **180** to compute the angle θ of the markers **180**, the sewing machine **1** can compute the reference angle θ more precisely than in a case where only one marker is used. Therefore, the sewing machine **1**, by using the markers **180** that are positioned in the marker area **87** and the marker area **88** as references, can set the position and the angle of the partial pattern in relation to the X carriage **22** more accurately than in a case where only one marker is used in computing the reference angle θ.

The pattern data can be corrected to match the position and the angle of the embroidery pattern that are specified by the setting condition. In the sewing machines **1** that are used second and later, the setting condition is acquired from the history data that are received as Step S**5**. Therefore, the time and effort that are required for the user to input the setting condition respectively to the individual sewing machines **1** can be eliminated. Furthermore, it is possible to avoid a situation in which the relative positioning of the partial patterns that are sewn in the plurality of the sewing machines **1** is unintentionally changed due to a mistake by the user in inputting the setting condition to the individual sewing machines **1**, respectively. The time and effort that are required for the user to input the pattern condition to the individual sewing machines **1** can be eliminated in the same manner, respectively. It is possible to avoid a situation in which an incorrect partial pattern is sewn due to a mistake by the user in inputting the pattern condition to the individual sewing machines **1**, respectively. In addition, because the bottom surfaces of the markers **180** are coated with a transparent adhesive, the markers **180** can be used by affixing them onto the work cloth **39**. In a case where the markers **180** are no longer needed after the sewing is completed, the user can easily peel the markers **180** off the work cloth **39**. The user can also easily change the positions where the markers **180** are affixed onto the work cloth **39**.

The sewing system of the present disclosure is not limited to the embodiment that is described above, and various types of modifications may be made within the scope of the present disclosure. For example, the modifications that are described below from (A) to (G) may be made as desired.

(A) The number of the sewing machines **1** that are included in the sewing system **100** is not limited to being two and may be any number that is at least two. The number of the needle

bars that are provided in the sewing machine **1** may be one and may also be more than one. The sewing machines **1** included in the sewing system **100** are capable of communicating with one another, the communication devices and the method of connecting them can be modified as desired. For example, a plurality of the sewing machines **1** may communicate wirelessly. In a case where a plurality of the sewing machines **1** are connected by wire, they may be connected by a LAN cable for example, instead of by a USB cable. In the sewing system **100** that is described above, a plurality of the sewing machines **1** are provided that have the same physical configuration and the same electrical configuration, but a plurality of the sewing machines **1** may also be provided that have different physical configurations and different electrical configurations. In that case, it shall be possible to attach the same embroidery frame in the plurality of the sewing machines **1**, and the all of the sewing machines **1** shall be capable of sewing in accordance with the same embroidery data.

(B) The configuration of the sewing machine **1** can be modified as desired. For example, the type and the positioning of the image sensor **151** may be modified as desired. The image sensor **151** may also be an image capture element other than a CMOS image sensor, such as a CCD camera or the like, for example. The direction in which the embroidery frame moving mechanism **11** moves the X carriage **22**, for example, can also be modified as desired.

(C) The sizes and shapes of the markers, the design of the markers, the number of the markers, and the marker areas can each be set as desired. The design of the markers may be any design that makes it possible to specify the markers based on the image data of the markers that are captured and acquired. For example, the colors with which the upper right area **108**, the lower left area **109**, and the like of the markers **180** are filled in are not limited to being white and black, and any other combination of colors that provides a clear contrast may also be used. The markers may also be modified according to the color and the pattern of the work cloth **39**, for example.

The number of the markers may also be defined as desired, taking into consideration the precision of the positioning of the partial pattern and the time that is required for executing the main processing. In a case where the number of the markers is greater than one, the plurality of the markers may all be of the same type, and they may also be of a plurality of types. The marker area may also be at least one of the embroidery frame **84** that is attached to the X carriage **22** and the work cloth **39** that is held by the embroidery frame **84**. The marker areas may also be defined in advance, as in the present embodiment, and may be positioned anywhere on the work cloth **39**, for example. In a case where the marker area is defined in advance, the processing that specifies the markers based on the image data is simpler than in a case where the position of the marker area is defined as desired.

Furthermore, for example, as in a modified embodiment that is shown in FIG. **12**, the markers may also be positioned in an embroidery frame **384**. In FIG. **12**, the same reference numerals are assigned in the same sort of configuration as that of the embroidery frame moving mechanism **11** in FIG. **4**. As shown in FIG. **12**, a marker **282** on which the first circle **101** is drawn and a marker **281** on which the second circle **102** is drawn may also be used. In this case, the marker **281** and the marker **282** may be distinguished by the sizes of the circles. As in FIG. **12**, the marker area may also be set in coupling portions **389** of the embroidery frame **384**. In a case where the markers **281**, **282** are drawn on the embroidery frame **384**, as in FIG. **12**, it is possible in the sewing machine **1** for the time and effort that are required for the user to place the markers in the marker areas to be eliminated and to reliably avoid a situation in which the markers are placed in positions that are not in the marker areas.

(D) The method of acquiring the pattern condition can also be modified as desired. For example, Japanese Laid-Open Patent Publication No. 2009-22400 discloses a method for allocating the partial patterns to the individual sewing machines **1** automatically, the relevant portions of which are herein incorporated by reference. In the sewing machines **1** that will be used second and later, the pattern condition is acquired from the history data that are transmitted from the sewing machine **1** that has been used immediately prior to the current sewing machine **1**, but the user may also input the pattern condition to the individual sewing machine **1** in which the partial pattern will be sewn, respectively, for example. A pattern condition that is stored in an external storage device such as a memory card or the like, for example, may also be acquired. The content of the pattern condition may also be modified as desired. Furthermore, in a sewing system in which the condition is set such that the partial pattern that is sewn can be sewn without the thread spools being changed, for example, the sewing order numbers of the partial patterns for which the sewing has already been completed (hereinafter called the completed numbers) may be defined in the pattern condition. In that case, the sewing machine **1** that has acquired the completed numbers may set as the at least one partial pattern to be sewn at least one partial pattern whose sewing order number is at least one greater than the highest of the completed numbers and that can be sewn without the thread spools **13** being changed. This makes it possible to eliminate the time and effort that are required for the user to allocate the partial patterns to the individual sewing machines **1** while taking into consideration the colors of the threads of the thread spools **13** that are attached to the sewing machines **1**.

(E) The embroidery pattern that is sewn by the sewing system **100** may also be modified in various ways. For example, an aggregation of a plurality of patterns may also serve as a single pattern. Furthermore, for example, the content of the setting condition and the method for acquiring the setting condition may also be modified as desired. For example, in the sewing machines **1** that will be used second and later, the setting condition may also be input by the panel operation. Moreover, in a case where the positioning of the embroidery pattern is not changed in relation to the initial positioning, the position and the angle in relation to the X carriage **22** may also be set based on the initial positioning, for example. In that case, the setting condition does not need to be acquired. A rate of enlargement or reduction of the embroidery pattern may also be set along with the setting condition, for example. In that case, the pattern data may be corrected in accordance with the set rate of enlargement or reduction.

(F) The first and second marker data may also include one of the position and the angle of the marker in relation to the X carriage **22**. The method for computing the first marker data, for example, may also be modified as desired, in accordance with the first marker data and the markers. For example, in a case where the angle is computed as a part of the first marker data, based on the image data for one of the markers **180**, the angle may also be computed based on the coordinates of the center of the first circle **101** and the coordinates of the center of the second circle **102**. As another example, in a case where the position is computed as a part of the first marker data, based on the image data for two of the markers **180**, the midpoint of a line segment that connects the centers of the first circles **101** of the two markers **180** may be computed as

the position of the marker. For example, in a case where the first marker data are only the position of the marker, the angle of the partial pattern is not corrected according to the correction condition at Step S**120**. In that case, the angle of the partial pattern is set based on the initial position of the partial pattern that is defined by the coordinate data in the pattern data and on the setting condition that is acquired at Step S**80**. Similarly, in a case where the first marker data is only the angle of the marker, the position of the partial pattern is set based on the initial position of the partial pattern and on the setting condition.

(G) The content of the history data and the method for transmitting the history data can be modified as desired, provided that the history data are transmitted to the sewing machine **1** that will be used later. For example, history data that include associations between the partial patterns and the IDs of the sewing machines **1** may also be transmitted to all of the sewing machines **1** that are included in the sewing system **100**. In that case, the sewing machines **1** that have received the history data may specify the partial patterns that are associated with their own IDs, based on the received history data. In a case where the sewing system **100** includes two sewing machines **1**, as it is in the present embodiment, for example, the sewing machine **1** that has performed the sewing may set the other sewing machine **1** as the sewing machine **1** that will be used later. As another example, the sewing machine **1** may also specify the sewing machine **1** that will be used later based on one of the pattern condition that is acquired at Step S**15** and the history data that are acquired at Step S**5**, then transmits the history data to the specified sewing machine **1**. As yet another example, the image data that are acquired by capturing of the markers **180** may also be included in the history data instead of the first marker data. In that case, the sewing machine **1** that has received the history data may compute the second marker data based on the received image data.

The apparatus and methods described above with reference to the various embodiments are merely examples. It goes without saying that they are not confined to the depicted embodiments. While various features have been described in conjunction with the examples outlined above, various alternatives, modifications, variations, and/or improvements of those features and/or examples may be possible. Accordingly, the examples, as set forth above, are intended to be illustrative. Various changes may be made without departing from the broad spirit and scope of the underlying principles.

What is claimed is:

1. A sewing machine that is included in a sewing system that, using a plurality of the sewing machines, performs sewing of a single embroidery pattern on a work cloth that is held by an embroidery frame, the sewing machine comprising:

a transfer device that includes a carriage to which the embroidery frame can be attached and that is adapted to transfer the carriage;

a sewing device that moves a needle bar, to a bottom end of which a needle is attached, up and down;

an image capture device that is adapted to capture at least one image of at least one marker that is positioned in a marker area, the marker area being on at least one of the embroidery frame that is attached to the carriage and the work cloth that is held by the embroidery frame;

a communication device that is adapted to transmit and receive data among the plurality of the sewing machines;

a data computation device that computes, as first marker data, at least one of a reference position and a reference angle of the at least one marker in relation to the carriage, based on image data that are generated by the image capture device;

a first control device that transmits the first marker data that are computed by the data computation device, through the communication device, to another sewing machine, among the plurality of the sewing machines, that will be used later than the sewing machine;

a marker data acquisition device that acquires, as second marker data, through the communication device, the first marker data that are transmitted from another sewing machine among the plurality of the sewing machines;

a sewing condition acquisition device that acquires a sewing condition that includes a condition for specifying at least one partial pattern among a plurality of partial patterns that form the embroidery pattern as a whole, the at least one partial pattern being allocated to the sewing machine;

a pattern data acquisition device that acquires pattern data that are data for sewing the at least one partial pattern that is specified by the sewing condition and that is allocated to the sewing machine;

a condition computation device that computes, as a correction condition, at least one of two differences, the two differences being a difference between a first position and a second position, and a difference between a first angle and a second angle, the first position being the reference position that is included in the first marker data that are computed by the data computation device, the second position being the reference position that is included in the second marker data that are acquired by the marker data acquisition device, the first angle being the reference angle that is included in the first marker data, and the second angle being the reference angle that is included in the second marker data;

a correction device that, based on the correction condition that is computed by the condition computation device and on the sewing condition that is acquired by the sewing condition acquisition device, sets a position and an angle of the at least one partial pattern in relation to the carriage and corrects the pattern data that are acquired by the pattern data acquisition device; and

a sewing control device that performs the sewing of the at least one partial pattern by controlling the transfer device and the sewing device in accordance with the pattern data that are corrected by the correction device.

2. The sewing machine according to claim **1**, wherein:

a plurality of the markers are positioned in the marker area;

the data computation device computes the reference angle, using the image data that the image capture device has generated for the plurality of the markers; and

the condition computation device computes, as at least a portion of the correction condition, the difference between the first angle and the second angle.

3. The sewing machine according to claim **1**, wherein:

the sewing condition includes a setting condition that is a condition for specifying settings for a positioning of the embroidery pattern;

the sewing machine further comprises a second control device that transmits the setting condition through the communication device to another sewing machine among the plurality of the sewing machines; and

the sewing condition acquisition device acquires, through the communication device, as a portion of the sewing condition, the setting condition that is transmitted from another sewing machine among the plurality of the sewing machines.

4. The sewing machine according to claim **1**, further comprising a second control device that transmits, through the communication device to another sewing machine among the

plurality of the sewing machines, a condition for specifying the at least one partial pattern that is allocated to the other sewing machine,

wherein the sewing condition acquisition device acquires, through the communication device, as at least a portion of the sewing condition, the condition that is transmitted from another sewing machine among the plurality of the sewing machines.

5. A computer-readable medium storing a control program executable on a sewing machine that is included in a sewing system that, using a plurality of the sewing machines, performs sewing of a single embroidery pattern on a work cloth that is held by an embroidery frame, the program comprising instructions that cause a controller of the sewing machine to perform the steps of:

computing, as first marker data, based on image data that are generated by an image capture device that captures at least one image of at least one marker that is positioned in a marker area that is on at least one of the embroidery frame that is removably attached to a carriage and the work cloth that is held by the embroidery frame, in relation to the carriage, at least one of a reference position and a reference angle of the at least one marker;

transmitting the computed first marker data, through a communication device that is adapted to transmit and receive data among the plurality of the sewing machines, to another sewing machine, among the plurality of the sewing machines, that will be used later than the sewing machine;

acquiring, as second marker data, through the communication device, the first marker data that are transmitted from another sewing machine among the plurality of the sewing machines;

acquiring a sewing condition that includes a condition for specifying at least one partial pattern among a plurality of partial patterns that form the embroidery pattern as a whole, the at least one partial pattern being allocated to the sewing machine;

acquiring a setting condition that is a condition for specifying a position and an angle of the embroidery pattern in relation to an initial positioning of the embroidery pattern;

acquiring pattern data that are data for sewing the at least one partial pattern that is specified by the sewing condition and that is allocated to the sewing machine;

computing, as a correction condition, at least one of two differences, the two differences being a difference between a first position and a second position, and a difference between a first angle and a second angle, the first position being the reference position that is included in the computed first marker data, the second position being the position that is included in the second marker data, the first angle being the reference angle that is included in the first marker data, and the second angle being the reference angle that is included in the second marker data;

setting a position and an angle of the partial pattern in relation to the carriage, based on the correction condition and the sewing condition, and correcting the pattern data; and

performing the sewing of the partial pattern by controlling, in accordance with the corrected pattern data, a transfer device and a sewing device, the transfer device including the carriage and being adapted to transfer the carriage, and the sewing device being adapted to moving a needle bar, to a bottom end of which a needle is attached, up and down.

6. The computer-readable medium according to claim **5**, wherein:

the at least one image is captured of a plurality of the markers that are positioned in the marker area;

the image data that correspond to the captured at least one image are generated,

the reference angle is computed based on the generated image data for the plurality of the markers; and

the difference between the first angle and the second angle is computed as at least a portion of the correction condition.

7. The computer-readable medium according to claim **5**, wherein:

the program further includes an instruction that causes the controller of the sewing machine to perform the step of transmitting a setting condition through the communication device to another sewing machine among the plurality of the sewing machines, the setting condition being a condition for specifying settings for a positioning of the embroidery pattern; and

the setting condition that is transmitted from another sewing machine among the plurality of the sewing machines is acquired, through the communication device, as a portion of the sewing condition.

8. The computer-readable medium according to claim **5**, wherein:

the program further includes an instruction that causes the controller of the sewing machine to perform the step of transmitting, through the communication device to another sewing machine among the plurality of the sewing machines, a condition for specifying the at least one partial pattern that is allocated to the other sewing machine; and

the condition that is transmitted from another sewing machine among the plurality of the sewing machines is acquired, through the communication device, as at least a portion of the sewing condition.

* * * * *